2-301-
4016

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 701 337 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.03.1996 Bulletin 1996/11

(51) Int. Cl.[6]: H04B 7/26

(21) Application number: 95114123.3

(22) Date of filing: 08.09.1995

(84) Designated Contracting States:
DE FR GB SE

(30) Priority: 09.09.1994 JP 216184/94
01.09.1995 JP 224898/95

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(54) Mobile communication system using various multiple access methods

(57) A mobile communication system in which various access methods may be selected according to the user's priority. In the mobile communication system, each of a mobile station and radio base stations has a radio processor, which has TDMA, CDMA and FDMA communication units. The CDMA communication unit comprises channel coders each for performing a primary modulation to a transmitting signal, spread-spectrum code generators for respectively generating different spread-spectrum signals, a clock generator/controller for controlling the generation of chip clocks to control the generation of the spread-spectrum codes, oscillators for setting different carrier frequencies to outputs calculated as products, and a CPU for generally controlling various parts or elements to control the assignment of a CDMA signal or a TDMA signal to an arbitrary time slot transmitted from the TDMA communication unit. The radio processor transmits different signals of different access methods existing in each time slot of the same frame different signals.

The invention disclosed in this Motorola patent may be considered as based on the same problem as the present invention.

5. U.S. Pat. 5,260,967, for CDMA/TDMA Spread Spectrum Communications System and Method", filed Jan. 13, 1992 by D.L. Schilling and assigned to IDC Inc.

This U.S. Patent discloses a system in which time division multiple access (TDMA) is carried out for the synchronization code and plural data and then the spread-spectrum is performed with a chip code. According to claims 52 and 56 of the U.S. Patent, the TDMA is carried out for the spread-spectrum-processed-synchronization-code and the combined-spread-spectrum signals.

6. U.S. Pat. No. 5,299,266, for "Adaptive Power Control for a Spread Spectrum Communications System and Method", filed Nov. 19, 1991 by D.L. Schilling and assigned to IDC Inc. discloses a mobile station which receives the spread spectrum electric wave from one land station and has a transmitter to transmit the second spread-spectrum signal corresponding to a strength of the receiving signal (AGC (Auto Gain Control) signal).

7. Japanese Patent Laid-Open Publication No. Hei 5-145470, for "Multiple Access Mobile Communication System", filed Nov. 18, 1991 by NTT (Inventors: Hata Seiji, et al) discloses a system which is characterized in that the electric wave of the CDMA method of different time slots is assigned to each of the different sector cells.

8. U.S. Pat. No. 5,345,467, for CDMA Cellular Hand-Off Apparatus and Method", filed Oct. 8, 1992 by G.R. Lomp, et al and assigned to IDC Inc. discloses the mobile station which received the first spread spectrum electric wave from the first land station provides another correlation receiver, such as a matching filter, to receive the second spread-spectrum signal from the second land station.

9. U.S. Pat. No. 5,311,542, for "Spread Spectrum Communication System", filed Oct. 9, 1992 by Kenneth C. Eder and assigned to Honeywell Inc. discloses a system in which time multiplication is performed for the plural time division information having preambles and then the spread-spectrum is then performed.

10. U.S. Pat. 5,319,672, for Spread Spectrum Communication System", filed Mar. 1, 1993 by M. Sumiya, et al and assigned to KDD Co. discloses a system in which the land station transmits plural spread-spectrum electric waves and has a plurality of transmitters whose transmitting frequencies are different each other.

11. WO 94/21056, for "Random Access Communication Method by Use of CDMA and System for Mobile Stations which Use the Method", filed Mar. 5, 1993 by NTT Docomo (Inventors: Umeda, et al) describes that "spread-spectrum code selection is performed by each burst" in claim 19 and subsequent claims and shows "multiple random access" in FIGS. 9 and 14.

12. WO 93/19537, for "Bidirectional Communication Method in Cellular System, filed Mar. 3, 1995 by ERICSSON.

13. WO 93/03558, for "Communication System with Channel Selection", filed Feb. 18, 1993 by MOTOROLA

14. EP 471656, for "Cellular Mobile Radio Telephone System Reliability Enhancement", filed Feb. 19, 1992 by ERICSSON.

15. EP 209185, for "Free-channel Search for Cellular Mobile Radio having Mobile Station Comparing Common-channel Reception with Interference Threshold and Identifying Interfering Fixed Station", filed Jan. 21, 1987 by PHILIP.

Patent Family JP62015941 filed Jan. 24, 1987.

FIG.130 of the accompanying drawings shows a conventional correlator to be used on the receiving side of the CDMA method. In FIG. 130, a portion indicated by dotted lines is an envelope correlation network for detecting the correlation between the spread-spectrum code and the received signal. The correlator forms a noncoherent delay-lock loop using the envelope correlation network and judges the correlation with the received spread-spectrum code using the formed loop.

However, in the conventional mobile communication system, there was a problem that the user could not select the most suitable access method among various access methods. Even if any of the foregoing related art publications proposes any similar means, it is totally silent about a more detailed configuration and method in order to realize it.

For example, the above publication 5 is silent about a time multiplication of the information of the constantly divided time slot of the TDMA method in which the spread-spectrum is not performed and the information in which the spread-spectrum is performed. It still silent that the information in which the spread-spectrum is performed by CDMA method is divided by a definite time section.

Further, in the above publication 6, two sets of receivers and transmitters are required in the mobile station when two information channels of the CDMA method are simultaneously set between two land stations and one mobile station in order to realize the seamless hand-off.

In the above publication 7, it is not realized that the electric wave of the CDMA method is set to be the same time slot of the TDMA method.

In the above publication 8, two sets of receivers, such as correlation receivers, and two sets of transmitters are required in the mobile station when two information channels of the CDMA method are simultaneously set between two land stations and one mobile station in order to realize the seamless hand-off.

According to a sixth aspect of the invention, there is provided a mobile communication system which includes a mobile station and radio base stations for performing wireless commutation between the stations using a predetermined method selected from a number of multiple access methods, wherein each of the stations comprises: TDMA communication means for assigning TDMA signals to time slots, which are contained in a frame, to perform communication based on a TDMA method; CDMA communication means having a number of spread-spectrum code generators, which generate different spread-spectrum codes, and adapted for communication of CDMA signals based on a CDMA method; and control means for controlling each station to selectively assign the TDMA signal or the CDMA signal to each of the time slots; the CDMA communication means being adapted for assigning the different spread-spectrum codes, which are generated by the spread-spectrum code generators, respectively to the time slots in such a manner that both the TDMA and CDMA signals exist in the time slots.

According to a seventh aspect of the invention, in each of the fourth, fifth and sixth inventions, the control means controls both the communication means in such a manner that both the TDMA and CDMA signals exist in one frame. In this seventh invention, even when a talking connection is provided in a certain access method, it is possible to change the access method, without cutting off the channel, by using another time slot by a different access method.

According to an eighth aspect of the invention, in each of the fourth, fifth and sixth invention, the control means controls the generation of the spread-spectrum codes by the spread-spectrum code generator.

According to a ninth aspect of the invention, in each of the fourth, fifth and sixth invention, the control means decides an access method to be used for communication with another station based on an access method deciding condition and assigns signal, which are according to the decided access method, to a predetermined time slot.

According to a tenth aspect of the invention, in the ninth invention, the mobile communication system further includes an exchange for controlling communications between the mobile station and the radio base stations, the exchange having storage means for storing the access method deciding condition.

In each of the ninth and tenth invention, when the mobile station is in communication with the radio station in an access method, it is possible to change the communication into another mode by another access method based on an access method deciding condition, such as channel efficiency, channel reliability or the user's demand.

According to an eleventh aspect of the invention, in each of the fourth, fifth and sixth invention, the CDMA communication means at each radio base station has channel coders located in association with the respective time slots for performing a primary modulation to transmitted information, and the spread-spectrum code generator for generating different spread-spectrum codes one for each of the time slots, and wherein the control means assigns the CDMA signals generated based on product information of an output of each channel coder associated with the respective time slot and the corresponding spread-spectrum code.

According to a twelfth aspect of the invention, in each of the fourth, fifth and sixth invention, the CDMA communication means has a number of channel coders in association with each of the time slots for performing a primary modulation to transmitted information, and the spread-spectrum code generator for generating different spread-spectrum codes one for each of the time slots, and wherein the control means assigns the CDMA signals generated based on product information of an output of each channel coder and each spread-spectrum code to the time slots to assign a number of channels to one of the time slots.

According to a thirteenth aspect of the invention, in the twelfth invention, the control means sets a number of the channels of the same access method for the same time slot.

According to a fourteenth aspect of the invention, in each of the fourth, fifth and sixth inventions, the mobile station has receiving-state detecting means for detecting a state of receiving signals from a number of the radio base stations, and the control means sets, based on the detected state of receiving signals, a separate channel between the mobile station and another radio base station using a time slot different from the time slot presently occupied by the channel. With this arrangement, even while the mobile station is in communication with one radio base station, it is possible to realize the seamless hand-off without discontinuing communication between the mobile station and another radio base station.

According to a fifteenth aspect of the invention, in any of the first through sixth inventions, the CDMA communication means has means for generating empty time slot.

According to a sixteenth aspect of the invention, in any of the first through sixth inventions, the CDMA communication means has a initial value setting unit for arbitrarily setting an initial value of the spread-spectrum code generated by each spread-spectrum code generator.

According to a seventeenth aspect of the invention, there is provided a mobile communication system which includes a mobile station and radio base stations for performing wireless communication between the stations using a predetermined method selected from a number of multiple access methods, wherein each of the stations is loaded with a spread-spectrum code generator for generating a number of spread-spectrum codes and has a noncoherent delay lock loop for detecting the spread-spectrum code assigned to the CDMA signal contained in each time slot received based on the TDMA method. With this arrangement, it is possible to detect the spread-spectrum code, which is contained in the received time slot, by a single set of receivers.

FIG. 25 is a diagram showing the manner of synchronous supplement of the noncoherent delay-lock loop of FIG. 24;

FIG. 26 is a block diagram showing a plurality of correlator having a plurality of envelope relation networks in the first embodiment;

FIG. 27 is a diagram showing time slots on the transmitting side in a multi frame in the first embodiment;

FIG. 28 is a fragmentary block diagram showing the transmitter of the CDMA communication unit of the radio base station in the first embodiment;

FIG. 29 is a diagram showing the structure of a channel coder of FIG. 28;

FIG. 30 is a diagram showing the content of an output of the CDMA communication unit of FIG. 28;

FIG. 31 is a fragmentary block diagram showing the transmitter of the CDMA communication unit of the mobile station having only a single system of information input, in the first embodiment;

FIG. 32 is a diagram showing an example of time slot to be transmitted from a modulator of FIG. 31;

FIG. 33 is a diagram showing an interior structure of a spread-spectrum code generator of FIG. 31;

FIG. 34 is a diagram showing an example in which a first time slot of the transmitting frame is used as a common channel for both the CDMA method and the TDMA method, in the first embodiment;

FIG. 35 is a diagram showing a frame in which a TDMA signal and a CDMA signal are assigned to the first and second time slots, respectively, in the first embodiment;

FIG. 36 is a block diagram showing a main part of a transmitter of the mobile station in the first embodiment;

FIG. 37 is a diagram showing the relationship between each time slot and the occupied frequency in the first embodiment;

FIG. 38 is a block diagram showing a main part of the transmitter of the CDMA communication unit of the radio base station in the first embodiment;

FIG. 39 is a timing chart of a control signal to be transmitted from a clock controller of FIG. 38;

FIG. 40 is a timing chart of another control signal to be transmitted from the clock controller of FIG. 38;

FIG. 41 is a block diagram showing a main part of the transmitter of a communication station in the first embodiment;

FIG. 42 is a table showing an example of setting chip rates in a chip rate setting memory of FIG. 41;

FIG. 43 is a diagram showing the structure of a transmitting frame in the first embodiment;

FIG. 44 is a diagram showing an example of the occupied frequency width associated with the respective chip rate in the first embodiment;

FIG. 45 is a block diagram showing a main part of the transmitter of the radio base station or the mobile station in the first embodiment;

FIG. 46 is a diagram showing an example of variation of carrier frequency controlled according to a carrier frequency controller in the first embodiment;

FIG. 47 is a diagram showing a different mode of use of the whole mobile communication system of the first embodiment;

FIG. 48 is a diagram showing an example of manner in which TDD frequencies are employed in wireless connection of various multiple access methods between the mobile station and the radio base station in the first embodiment;

FIG. 49 is a diagram showing another example of manner in which FDD frequencies are employed in wireless connection of various multiple access methods between the mobile station and the radio base station in the first embodiment;

FIG. 50 is a diagram showing a relationship between time slots in a multi frame, in the case of TDD, on the transmitting side of the radio base station in the first embodiment;

FIG. 51 is a diagram showing a relationship between time slots in a multi frame, in the case of TDD, on the receiving side of the radio base station in the first embodiment;

FIG. 52 is a diagram showing a relationship between time slots in a multi frame, in the case of FDD, on the transmitting side of the radio base station in the first embodiment;

FIG. 53 is a diagram showing a relationship between time slots in a multi frame, in the case of FDD, on the receiving side of the radio base station in the first embodiment;

FIG. 54 is a diagram showing an example in which a signal of CDMA/TDD method employs two time slots in the first embodiment;

FIG. 55 is a diagram showing an example in which a signal of CDMA/FDD method employs two time slots in the first embodiment;

FIG. 56 is a diagram showing an example in which a signal of TDMA/TDD method employs three or two time slots in the first embodiment;

FIG. 57 is a diagram showing an example in which a signal of TDMA/FDD method employs three or two time slots in the first embodiment;

FIG. 58 is a diagram showing another different mode of use of the whole mobile communication system in the first embodiment;

FIG. 59 is a block diagram showing the structure of a mobile station in the first embodiment;

FIG. 60 is a block diagram showing a radio base station of the private system in the first embodiment;

FIG. 92 is a table showing information channel information to be notified to the radio base station from the mobile station via the control channel in the twelfth embodiment;

FIG. 93 is a block diagram of a mobile communication system according to a thirteenth embodiment of the invention, showing the system when a position registration request is made from the mobile station to the radio base station;

FIG. 94 is a block diagram showing a position registration calling unit of FIG. 93;

FIG. 95 is a block diagram of a mobile communication system according to a fourteenth embodiment of the invention, showing the system when a position registration request is made from the mobile station to the radio base station;

FIG. 96 is a flowchart showing the link level procedure in the fourteenth embodiment;

FIG. 97 is a block diagram of a mobile communication system according to a fifteenth embodiment of the invention, showing an example of an accounting system considering channel efficiency;

FIG. 98 is a detailed block diagram showing a system discriminating mechanism of the mobile communication system of the fifteenth embodiment;

FIG. 99 is a diagram showing an example in which a channel efficiency is set based on the time slot and the occupied frequency in the fifteenth embodiment;

FIG. 100 is a block diagram of a mobile communication system according to a sixteenth embodiment of the invention, showing an example of an accounting system considering channel reliability;

FIG. 101 is a block diagram showing a system discriminating mechanism of the mobile communication system of the sixteenth embodiment;

FIG. 102 is a diagram showing an example of setting of channel efficiency and channel reliability in the sixteenth embodiment;

FIG. 103 is a diagram of a spectrum of CDMA wave, as used by s number of channels, in the sixteenth embodiment;

FIG. 104 is a diagram of a spectrum of CDMA wave, as used by 3s number of channels, in the sixteenth embodiment;

FIG. 105 is a block diagram showing a system discriminating mechanism in a mobile communication system according to a seventeenth embodiment of the invention;

FIG. 106 is a block diagram showing methods selected by three mobile stations of FIG. 105;

FIG. 107 is a flowchart showing the access method selecting procedure in the seventeenth embodiment;

FIG. 108 is a diagram showing the manner in which frequencies are employed in order for PBX to set channel reliability in a mobile communication system according to an eighteenth embodiment;

FIG. 109 is a flowchart showing a process for judging hand-off during talking using the FDMA method in a mobile communication system according to a nineteenth embodiment of the invention;

FIG. 110 is a flowchart showing a process for judging hand-off during talking using the CDMA method in a mobile communication system according to a twentieth embodiment of the invention;

FIG. 111 is a flowchart showing a process for judging hand-off during talking using the FDMA method in a mobile communication system according to a twenty-first embodiment of the invention;

FIG. 112 is a flowchart showing the procedure of hand-off to an adjacent cell in a mobile communication system according to a twenty-second embodiment of the invention;

FIG. 113 is a table showing control channel information in the adjacent system in the twenty-second embodiment;

FIG. 114 is a table showing information channel information of the adjacent system in the twenty-second embodiment;

FIG. 115 is a flowchart showing the hand-off procedure in which the priority method is designated to an adjacent cell, in a mobile communication system according to a twenty-third embodiment of the invention;

FIG. 116 is a flowchart showing the priority assignment setting process of FIG. 115;

FIG. 117 is a diagram showing a whole construction of a mobile communication system according to a twenty-fourth embodiment of the invention;

FIG. 118 is a block diagram showing a wireless processor equipped with a receiving electric power detecting function and a transmitting electric power controlling function, in the twenty-fourth embodiment;

FIG. 119 is a table showing control information possessed by CPU of FIG. 118;

FIG. 120 is a table showing examples of combinations of data rate per time slot, transmission type and chip rate, which are of electric waves from adjacent stations in the twenty-fourth embodiment;

FIG. 121 is a diagram showing an example of configuration of time slot of the electric wave from the radio base station of the public system in the twenty-fourth embodiment;

FIG. 122 is a diagram showing an example of configuration of time slot of TDMA/CDMA waves from two adjacent radio base stations in the twenty-fourth embodiment;

FIG. 123 is a table showing an example of electric intensity of the TDMA/CDMA radio wave received in the plural radio base stations from the mobile station in the twenty-fourth embodiment;

FIG. 124 is a diagram showing an example of the number of mobile stations in simultaneous communication for each time slot of the TDMA/CDMA radio wave with two adjacent radio base stations (in case of CDMA) in the twenty-fifth embodiment;

coding/decoding processor (data processor) 32 may carry out coding and decoding with an error correction code for digital information from a data input-output device 33. A speech transmitter and receiver 34 consist of a microphone and a sound receiver. The data input/output apparatus may be a facsimile, an image processing terminal, or like device capable of generating digital information.

FIG. 4 is a block diagram showing the functions of the radio base stations 4A, 4B, 4C as well as the function of the radio base station 6. A signal processor 35 has a function for processing protocol information for wireless communication. The signal processor 35 processes protocol information for the public switched telephone network 1 or the PBX 3 of the private system 2. A speech coding/decoding processor 36 converts standard speech digital information into compressed speech code and also converts compressed speech code into standard speech digital information. In this case compressed speech code is transmitted on the radio communication channel. A network interface processor 37 provides an interface for the public switched telephone network 1 and the PBX 3.

FIG. 5 is a block diagram showing a function of the PBX 3 in the private system 2. A line interface 38 is connected to each radio base station 4A, 4B and 4C. In the private system 2, when the mobile station 5 connected wirelessly to the radio base station 4A requests connection to the public switched telephone network 1, the public protocol land station processor 39 of the PBX 3 processes protocol information for the connection to the public switched telephone network 1. When the mobile station 5 requests communication with the subscriber 8 in the private system 2, the PBX 3 processes information of the connection by using a private protocol land station processor 40. A radio system controller 41 stores whether the signal being transmitted on the radio channel in use is based on the FDMA method, the TDMA method or the CDMA method. The stored information is downloaded in advance to the other land stations in neighboring cells. When the mobile station changes the connecting land station from one radio base station to another radio base station by a handover and so forth, the downloaded information can be utilized by the other land station.

FIG. 6 shows a general construction of the radio processor included in each of the radio base stations 4A, 4B, 4C, the radio base station 6 and the mobile station 5. A TDMA communication unit 44 is a TDMA communication means for communication based on the TDMA method. A CDMA communication unit 45 is a CDMA communication means for communication based on the CDMA method. An FDMA communication unit 46 is an FDMA communication means for communication based on the FDMA method. A modulator 47 modulates the input signal and generates a digital-modulated signal having an intermediate frequency. A high frequency amplifier 48 amplifies the signal being transmitted from an antenna 50 based on the control of a transmitting power controller 49. A switch 51 switches between a transmitting signal to the antenna 50 and a receiving signal from the antenna 50 during the times TX and RX. A high frequency amplifier 52 amplifier signals received by the antenna 50. A demodulator 53 demodulates the received signal and outputs it as output information. A controller 54 controls each section in radio processor 30.

FIG. 7 is a view similar to FIG. 6, but showing each of the TDMA communication unit 44, the CDMA communication unit 45 and the FDMA communication unit 46 as divided into the transmitting section and the receiving section. A TDMA time slot controller 44a generates time slots which compresses input information. A time slot multiplier 44b inputs input information which is a continuous digital signal and divides the input information and stores the divided input information into time slots. A CDMA code generator 45a generates a code for the CDMA for the input information. A code multiplier 45b multiplies the input information by the code generated by the CDMA code generator 45a. An FDMA frequency synthesizer 46a generates a modulation signal having a frequency allocated for communication. A converter 46b mixes the digital-modulated signal output from the modulator 47 in the modulation signal output from the FDMA frequency synthesizer 46a. A converter 46c extracts signals in the specific band among the received signals by using signals generated by the FDMA frequency synthesizer 46a. A code multiplier 45c detects a correlation between the code generated by the CDMA code generator 45a and the received signal, and extracts the signal which is the highest correlation. A time slot multiplier 44c extends the signal compressed in each time slot based on the control of the TDMA time slot controller 44a and generates a continuous digital signal.

Generally, the controller 54 of FIG. 7 selects one of the TDMA method, the CDMA method and the FDMA method for communication, based on the accessible method of the other end of communication.

As mentioned above, the mobile communication system of this embodiment generally comprises the mobile station, the radio base stations, and the exchange. The mobile station measures the received electric intensity of the radio signal received from the radio base station. When the intensity is below a threshold, the mobile station requests the handover process for exchanging the radio base station to another to which the mobile station is wirelessly connected, and requests a roaming process via the radio base station to the exchange. The radio base station is connected either wirelessly or through cables to the exchange and connected wirelessly to the mobile station according to various multiple access methods and modulation methods. The radio base station not only relays the communication between the mobile station and the exchange but also measures the received electric intensity of the radio signal emitted from the mobile station. When the intensity is below a threshold, the radio base station requests the handover process for exchanging the radio base station to another to which the mobile station is connected, and requests a roaming process to the exchange. The exchange has corresponding protocols for communicating with the present private system, another private system, the public system and the satellite public system.

of the spectrum locus 131 from CDMA#1 to #3 indicates the variation of radio wave frequency, thus showing emitted radio wave frequencies different depending on the time slot. FIG. 12 shows the manner in which the mobile communication system operates in the radio wave environment of FDMA/TDMA/CDMA method.

Setting Initial Values of Spread-spectrum codes

As described above, each spread-spectrum code generator 111 - 144 generates different codes within the same frame. The setting of an initial value of the spread-spectrum code will now be described.

Firstly, a head position of the spread-spectrum code of time sharing CDMA method is defined in the following manner.

FIG. 13 shows a set of shift registers constituting a part of the spread-spectrum code generator. The spread-spectrum code generator is equipped with shift registers S0 - S15 and generates spread-spectrum codes by using multipliers M1 - M3 and the shift action of the shift registers S0 - S15.

FIG. 14 shows a head position of the CDMA signals of the time slot on the transmitting side in a multi frame. FIG. 15 shows an initial value position of the spread-spectrum code of the time slot on the receiving side in a multi frame.

In the spread-spectrum code generator of FIG. 13, the bit "0" stored in the shift register S0 corresponds to a head bit of the initial value of the spread-spectrum code. In the time sharing CDMA method, the CDMA signal contained in sub-frames or a multi frame and encoded into separate time slots as shown in FIG. 2, based on the spread-spectrum codes. In the case of FIG. 2, a head bit of the initial value is assigned to a head position of the first sub-frame. Further, in the case of FIG. 15, a head bit of the initial value of the spread-spectrum code is assigned to a head position of the CDMA time slot RX 11 relating the first sub-frame. For example, if a spread-spectrum code is to be generated using a shift register as shown in FIG. 13, a reset state is treated as the initial value. And a head bit of the initial value generated by the shift register S0 is assigned to the head position of the time slot 21A of FIG. 2.

However, in the conventional time-non-divided CDMA method, a head position of the CDMA spread-spectrum code is not always the same position for every CDMA radio wave emitted into air. In this embodiment employing the time-divided CDMA signal, a head position of the CDMA spread-spectrum code is defined by using a common time frame with the TDMA method. If the conventional method is regarded as a non-synchronizing type, the method of this embodiment may be regarded as a synchronizing type. Given that the head position is thus defined, it is possible to facilitate synchronous supplementing the initial value of the spread-spectrum code of the CDMA method. However, defining the head position somehow deteriorates the privacy of radio wave itself of the conventional CDMA method. Although this method may yet have a problem from a military communications view point, it can meet the ordinary purposes of the public system, as long as the privacy of contents of communication is secured, so that the poor degree of privacy proofness of radio wave itself may be ignored. The proofness of privacy of communication contents is realized by superposing a privacy code over communication data itself; this is totally different from the privacy proofness of radio wave itself. This embodiment is characterized by that the synchronizing-type CDMA method is employed by synchronizing the first bit of the CDMA spread-spectrum code with the leading bit of the first time frame in a multi frame. It is also characterized by that the synchronized CDMA signal is assigned to the time slot of TDMA method.

The setting of initial values of all spread-spectrum codes to be assigned to the time slots will now be described.

FIG. 16 is a fragmentary block diagram of the CDMA communication unit equipped with an initial value setting unit 150 for setting the initial values of the spread-spectrum codes, which are generated by the four spread-spectrum code generators 111 - 114, to arbitrary values. FIG. 17 is an initial-value-of-spread-spectrum-code-generator setting unit 161 for setting the initial values of the spread-spectrum code generators in shift registers 163 carried by the respective spread-spectrum code generators. The shift registers 163 are in the form of flip-flops.

Each spread-spectrum code generator 111 - 114 receives a set initial value from the initial value setting unit 150 via a respective signal line 151, 152, 153, 154. The initial-value-of-spread-spectrum-code-generator setting unit 161 shown in Fig. 17 sets the initial values to the respective shift registers for every bit. Thus the setting of initial values of spread-spectrum codes is achieved by an initial value setting means that is constituted by the initial value setting unit 150 as well as the shift registers 163, adders 164 and feedback circuit 165 which are carried by the spread-spectrum code generators.

FIGS. 18 and 19 are diagrams showing the setting of initial values to the respective time slots and their time points. When such figures as Figures 18 and 19 are shown, it is not always clearly described whether the type is applied for the TDD (time division duplex) type or the FDD (frequency division duplex) type. As is apparent from FIGS. 18 and 19, each initial value is set to a head position of the corresponding time slot. FIG. 19 in particular shows an example in which an empty time slot 127 exists; in this case, no initial value is set.

Thus, according to this embodiment, it is possible to assign a spread-spectrum code, whose initial value is set arbitrarily, to a head position of the respective time slot.

The initial value setting function to be performed by the initial value setting unit 150 of FIG. 16 and the construction of FIG. 17 may be realized alternatively not only by hardware having CPU, memories, etc. as built-in components but by software. Specifically the four spread-spectrum code generators 111 - 114 may be constituted by software.

$$\begin{bmatrix} K_{1,1(t)} & K_{2,1(t)} & K_{3,1(t)} & \cdots\cdots & K_{n,1(t)} \\ K_{1,2(t)} & K_{2,2(t)} & K_{3,2(t)} & \cdots\cdots & K_{n,2(t)} \\ K_{1,3(t)} & K_{2,3(t)} & K_{3,3(t)} & \cdots\cdots & K_{n,3(t)} \\ K_{1,4(t)} & K_{2,4(t)} & K_{3,4(t)} & \cdots\cdots & K_{n,4(t)} \end{bmatrix}$$

Assuming that a receiving code string of the time slot Gi1 is expressed by Gi1(t), the result of correlation arithmetic of spread-spectrum code is obtained from a matrix of the following second equation:

$$\sum_{i=1}^{n} \sum_{1=T_{i10}}^{T_{i11}} Gi1(t) \begin{bmatrix} K_{1,1(t)} & K_{2,1(t)} & K_{3,1(t)} & \cdots\cdots & K_{n,1(t)} \\ K_{1,2(t)} & K_{2,2(t)} & K_{3,2(t)} & \cdots\cdots & K_{n,2(t)} \\ K_{1,3(t)} & K_{2,3(t)} & K_{3,3(t)} & \cdots\cdots & K_{n,3(t)} \\ K_{1,4(t)} & K_{2,4(t)} & K_{3,4(t)} & \cdots\cdots & K_{n,4(t)} \end{bmatrix}$$

Ki,j representing a maximum value of n x 4 elements of the above matrix is a correlation code to be detected. In this case, n x 4 arithmetic operations have to be performed simultaneously, and this arithmetic may be performed by 1 multi frame length of data Gi,j(t) and may be realized alternatively by a combination of CPU and software.

The length of spread-spectrum codes to be used may be relatively longer than that of the frame and may be substantially equal to 1 data symbol length. Such relatively short code is used for identification of information channel and is decoded using a matched filter or an SAW convolver device; however, the relatively short codes are already well known in the art, so their detailed description is omitted in this embodiment. Although, in the mobile communication system of this embodiment, these relatively short codes are used, the invention is not limited to the use of such relatively short codes. Various modifications or substitutions are possible for those skilled in the art without departing from the scope of the invention.

Another correlator for performing correlation arithmetic of spread-spectrum code of CDMA method for a plurality of time slots will now be described.

The correlator described below is characterized by having a plurality of noncoherent delay-lock loops, i.e., a plurality of envelope correlation network. FIG. 26 is a block diagram showing an example of correlator. This correlator makes synchronization with spread-spectrum codes of the CDMA method.

The envelope correlation network 87, 88, 89, 90 of FIG. 26 is a circuit that is functionally equivalent to a portion surrounded by dotted lines in FIG. 130, which shows the prior art. Built-in spread-spectrum code generators 81 - 84 of the receiving section of the communication station generate a string of spread-spectrum codes (N1+N2+N3+N4), and loop filters 91 - 94 outputs only when the spread-spectrum code string approaches the output signal of a receiver 85, i.e., the received signal. Thus the correlator performs synchronous supplementing. A correlation discriminator 95 detects a output voltage of the correlator and supplies a detection signal to a voltage control oscillator 86. The correlator in this embodiment forms a loop by the spread-spectrum code generators 81 - 84, the envelope correlation networks 87 - 90, the loop filters 91 - 94, the correlation discriminator 95 and the voltage control oscillator 86, and makes synchronization with the CDMA spread-spectrum codes received by the receiver 85, thus reproducing data. The voltage control oscillator 86 generates a clock signal 96 to the spread-spectrum code generators 81 - 84. The clock signal 96 is set so as to be outputted only at a portion of the first time slot 155 - 158 of each sub-frame as shown in FIG. 27 and so as to be stopped at the remaining time slots of the sub-frame. In the correlator of FIG. 26, the spread-spectrum codes are correlated with four time lags in order to compress the whole synchronizing time.

The receiving section in this embodiment may be composed of only a single set of the foregoing components, so each communication station may not have the receiving section for every information channel.

Though they constitutes a part of the receiving section in each communication station, the spread-spectrum code generators may serve also as those contained in the transmitting section of FIG. 20.

<u>Simultaneous Use of Access Method & Change of Access Method for Time Slot</u>

This embodiment is characterized by that the CDMA signal divided timewise as described above is assigned to the time slot of TDMA method.

In the example of FIGS. 11 and 12, the TDMA signal is assigned to the third time slot 134. This embodiment is characterized not only by that the time-divided CDMA signal is assigned to the time slot of the TDMA method but by that the TDMA signal and the CDMA signal are assigned to the time slot for continuous transmission. Thus in this embodiment, it is possible to transmit signals of different methods simultaneously in a mixed form. In this case, The

The mobile station of FIG. 36 includes an RF receiver 232 for receiving a telephone call, a correlation receiver 233 for performing reverse spread-spectrum on the CDMA signal, and a CH receiver 234 for detecting information contained in the TDMA signal. The mobile station, which serves usually as the CDMA receiver, can serve also as the TDMA receiver when the correlation receiver 233 is rendered inoperative, namely, if the information of the RF receiver 232 is directly inputted to the CH receiver 234.

Therefore, when the mobile station receives the frame of FIG. 35, it is possible to receive the TDMA signal in a normal form by rendering the correlation receiver 233 inoperative, even if the first channel of the first time slot is, for example, a control channel in the TDMA method.

Further, the mobile station renders the correlation receiver 233 operative to perform reverse spread-spectrum on the second time slot so that the CDMA bit information contained in the second time slot 252 as shown in FIG. 35 can be obtained.

Thus the same time slot can be used either for the TDMA signal or for the CDMA signal. Even if the same time slot is used for different methods, it is possible to recognize a signal of any of the different methods so that reliable reception can be achieved.

Construction for Simultaneous Use of Access Methods & Change of Access Method

As mentioned above, in this embodiment, the mobile communication system can be used with both the TDMA signal and the CDMA signal existing in the time slots contained in the same frame. The mobile communication system can be used also if the access method of a single time slot is changed into another.

In order to produce the foregoing results, the controller controls the spread-spectrum code generators to generate the spread-spectrum codes. For example, in a communication station, in which the spread-spectrum code generators are associated with the respective time slots, assuming the TDMA signal is to be transmitted, the controller renders the object spread-spectrum code generator inoperative to stop generating a spread-spectrum code so that the input information is transmitted as the TDMA signals.

Various parts or elements essential to perform this control will now be described.

FIG. 38 is a block diagram showing the transmitting section of the CDMA communication unit in the radio base station. In FIG. 38, the first time slot in the TDMA method can be allocated to a synchronization burst or a control channel, and the second, third and fourth slots can select any of the TDMA method and the CDMA method. The CDMA communication unit of FIG. 38 includes a chip rate generator 267 for generating a predetermined chip rate, a down counter 268 for counting the generated chip rate down to 1/2, 1/3, ...1/N, and a clock controller 269 for sending control signals to clock control gates 281 - 287 to control the supply of clocks to a synchronization burst generator 260, a control channel generator 261, information channel coders 262 - 265 and a chip code generator 266. Although the information channel coders 262 - 265 are elements identical with the channel coders 191 - 194 of FIG. 28, they are named differently to be identified from the control channel code generators. Further, the chip code generator 226 of FIG. 38 is identical in construction with the spread-spectrum code generator of FIG. 21 and an element identical with the above-mentioned spread-spectrum code generator. As is understood from FIG. 38, the chip code generator 266 generates a plurality of different spread-spectrum codes.

FIGS. 39 and 40 are timing charts of control signals to be sent from the clock generator 269, showing an example of control of the clock controller 269. The action of a chip clock controlling unit including the clock control gates 281 - 286 and the clock controller 269 will now be described using FIGS. 39 and 40.

Firstly, in FIG. 39, an example is shown in which the first and third time slots are in the TDMA method and the second and fourth time slots are in the CDMA method. The clock control gates 281, 282 associated with the synchronization burst generator 260 and the control channel generator 261 releases the clock only in the first time slot and prohibits the clock in the other time slots by control signals Csy and Cc. Since the first time slot is thus allocated in order to send the synchronization burst or the control channel, the supplying a clock t1 to the information channel coder 262 to output the information input 1 is normally prohibited in the clock control gate 283 by the control signal C1. Namely, in this example, the information channel coder 262 normally does not make the output. In this case, since the first time slot is used by the TDMA method, the chip code generator 266 may not perform spread-spectrum. Accordingly, the control signal Csp is set to prohibit the clock in the first time slot. In other words, the output of the chip clock tsp is prohibited by the clock control gate 287, and the operation of the chip code generator 266 is stopped also in this third time slot so that the electric wave of TDMA signal is emitted in the third time slot.

In FIG. 40, an example is shown in which the first time slot is allocated to the information channel. In this case, the clock control gates 281, 282, which are associated with the synchronization burst generator 260 and the control channel generator 261, of FIG. 38 prohibit the clock by the control signals Csy and Cc so that the electric wave of the synchronization burst or control channel is not emitted from the controlled radio base station as shown in FIG. 40. This is because, in the absence of emitted electric wave of the synchronization burst or control channel, another radio base station, which emits the electric wave of the synchronization burst or control channel, is located in the same position. In this example of FIG. 40, the first, second and fourth time slots are used by the CDMA method. Since only the third time slot is used

The controller 54 recognizes the mobile station accommodating the radio processor 30 or the access method to be used by the radio base station. For example, if the access method to be used is the TDMA method, the controller 54 renders the TDMA time slot controller 44a and the time slot multiplier 44b operative. On the other hand, the controller 54 does not render the CDMA code generator 45a and the FM (frequency modulation) function of the FDMA frequency synthesizer 46a operative.

Thus the signal in the TDMA method is emitted into air from the antenna 50. When the controller 54 does not render the CDMA code generator 45a and the FM function of the FDMA frequency synthesizer 46a operative, the code multiplier 45b and the converter 46b convert the frequency of the input signal without any other process and output the frequency-converted signal.

The process of the received signal is basically similar to the above-mentioned process of the transmitting signal. When receiving signals in the TDMA method, the controller 54 does not render the CDMA code generator 45a and the FM function of the FDMA frequency synthesizer 46a operative. The received signal is frequency-converted by the converter 46c and then pass through the code multiplier 45c. The controller 54 renders the TDMA time slot controller 44a operative and converts the received TDMA signal by the time slot multiplier 44c into a digital signal and demodulates the digital signal by the demodulator 53.

Thus the radio processor 30 of this embodiment has a function of selectively carrying out three different multi access methods of TDMA, CDMA and FDMA. For communication, the controller 54 selects one from these three multi access methods according to need, communication capacity of data or given communication environment. Of course, more than one access methods may be selected for communication. For example, composite communication of the TDMA method and the CDMA method may be carried out, or composite communication of the TDMA method and FDMA method may be carried out. Accordingly, by combining different access methods, it is possible to realize composite communication without canceling the original advantages of the individual access methods.

In this embodiment, the radio processor 30 for carrying out three multi access methods is illustrated. Alternatively, it may be a radio processor having two of the three multi access methods, or any other radio process having four or five multi access methods.

The mobile station in this embodiment operates according to the frequency division multi access (FDMA) method, the time division multi access (TDMA) method and the code division multi access (CDMA) method individually or in combination. Namely, the radio processor 30 carried by the mobile station is equipped with the controller for controlling the radio frequency of used radio wave and varying the output radio wave, and a modem for dealing with various transmission methods and various modulation methods, i.e. digital modulation methods (e.g., a Gaussian Minimum Shift Keying (GMSK), a $\pi/4$-quarter differential phase shift keying ($\pi/4$-QDPSK), a 16-value quadrature amplitude modulation (16QAM), and a multi-subcarrier 16-value quadrature amplitude modulation (M16QAM)) and analog modulation methods (e.g., an FM modulation method).

Specifically, the mobile station of this mobile communication system comprises the radio processor able to cope with one or more multi access methods and one or more modulation methods, the protocol processor able to cope with the signal methods of the private system and public system, a voice data processor, a handset, and data input-output device, thus enabling various communication methods.

Further, the radio base station of the mobile communication system comprises the radio processor able to cope with one or more multi access methods and one or more modulation methods, and the protocol processor able to cope with the signal methods of the private system and public system, thus enabling various communication methods. In the case of private system, the radio base station is also equipped with a network interface processor for performing an interface function with an electric public branch exchange (EPBX) in the case of private system or for performing an interface function with an exchange in the case of the public system.

Each of the mobile station and the radio base station has the radio signal processor in order cope with various communication methods.

The public branch exchange (PBX) 3 in this embodiment, as shown in FIG. 5, comprises a radio system controller 41, a position registration calling unit 42 for making a position registration even in a different system and for processing a roaming function, and a system recognition unit 55. The radio system controller 41 performs a handover sequence process, a receiving level query process, and a transmitting power control information process, and manages various access methods, various modulation systems, data transmitting speed, etc. If the mobile station having system information individually for the private system, the public system and the satellite system and being in communication within in this mobile communication system is moved out of the mobile communication system, namely, if the mobile station makes a handover between different communication systems, the radio base station receives a signal from the mobile station. The system recognition unit 55 judges, from the intensity of the received signal, the system to which the radio base station belongs. Upon receipt of a handover request information from the radio base station, the system recognition unit 55 transmits handover information to a handover destination system, including the satellite channel, other than the mobile communication system.

In this embodiment, a single time frame is divided into halves according to the TDD method, and is then divided into 2x according to the TDMA method, forming x channels. In the CDMA method using m multi frames each constituted by 2x time slots, correlation arithmetic of spread-spectrum codes of the CDMA method over a plurality of time frames in the multi frame.

Thus also in the case of TDD method, a plurality of access methods can be used in combination.

Communication in FDD Method

In FIG. 49, the transmission of spread-spectrum codes in the case of FDD of the CDMA method is illustrated. FIGS. 52 and 53 show a multi frame composed of four sub-frames in the case of FDD method.

FIG. 52 shows a relationship between time slots in a multi frame on the transmitting side in the radio base station. FIG. 53 shows a relationship between time slots in a multi frame on the receiving side in the radio base station. Portions TX11(61), TX12(62), TX13(63), TX14(64) of the individual sub-frames as a whole constitute a single CDMA transmitting signal. Portions of RX11(71), RX12(72), RX13(73), RX14(74) of the individual sub-frames as a whole constitute a single CDMA receiving signal. Reserve spread-spectrum of spread-spectrum codes according to the CDMA method is achieved by the correlation arithmetic of the spread-spectrum codes per bit with respect to the bits (N1+N2+N3+N4) of the related portions in the four sub-frames. This correlation arithmetic is carried out when receiving.

In this embodiment, a single time frame is divided by 2x according to the FDD method and the TDMA method, forming 2x channels. In the CDMA method using m multi frames each constituted by 2x time slots, correlation arithmetic of spread-spectrum codes of the CDMA method over a plurality of time frames in the multi frame.

Thus also in the case of FDD method, a plurality of access methods can be used in combination.

Use of Successive Time Slots of One Signal (CDMA)

FIGS. 54 and 55 show an example in which the signal of the CDMA method uses two time slots in each of CDMA#1 and CDMA#2; FIG. 54 shows the case of TDD, and FIG. 55 shows the case of FDD. The time to start using two time slots may be at the beginning of communication or anytime during communication. Assuming that communication using two time slots is identical in data rate with communication using one time slot, it is possible to transmit a double volume of information. If the data rate of communication using two time slots is reduced to a half the data rate of communication using one time slot in order to transmit the same information volume as that of the one-time-slot communication, the peak transmitting power can be reduced to a half. For example, in CDMA#1, two time slots T1 and T2 are used on the transmitting side while two time slots R1 and R2 are used on the receiving side.

If the mobile station in communication in CDMA#3 is short of peak transmitting power, CDMA#3 using one time slot is changed to CDMA#1 using two time slots, and communication at a half of the bit rate of CDMA#3 is selected, thus enabling continuous talking without interruption. In the mobile communication, in which originally the transmitting power is strictly limited, it is possible to select the two-time-slot-occupied type, like CDMA#1 or CDMA#2 of FIGS. 54 and 55, from the beginning of either a calling process or a paging process.

Thus by making the transfer rate of signals of the CDMA method multiple by an integer, i.e. 2, 3 as much as the transfer rate of signal of the TDMA method, it is possible to perform transmission control such as by increasing the transmitting information volume or supplementing the transmitting power shortage.

Use of Successive Time Slots of One Signal (TDMA)

FIGS. 56 and 57 show an example in which the signal of the TDMA method uses three time slots or two time slots in each of the slot 501A/501B of the TDMA method or 502A/502B of the TDMA method; FIG. 56 shows the case of TDD, and FIG. 57 shows the case of FDD. Assuming that each time slot employs the same data rate as the communication using one time slot, it is possible to transmit a triple or double volume of information. If two time slots or three time slots are used, the peak transmitting power may be reduced to 1/2 or 1/3 so that the same information volume as one-time-slot information volume can be transmitted at a data rate reduced to 1/2 or 1/3. If the mobile station in communication in the time slot 24A/24B of the TDMA is short of peak transmitting power, communication at a half of the bit rate of the time slot 502A/502B of the TDMA method is selected, thus enabling continuous talking without interruption. In the mobile communication, in which originally the transmitting power is strictly limited, it is possible to select the two-time-slot-occupied type or the three-time-slot-occupied type, like the slot 502A/502B of the TDD method or the slot 503A/503B of the FDD method in FIGS 56 and 57, from the beginning of either a calling process or a paging process.

Thus by making the transfer rate of signals of the TDMA method multiple by an integer, i.e. 2, 3, as much as the transfer rate of signal of the TDMA method, it is possible to perform transmission control such as by increasing the transmitting information volume or supplementing the transmitting power shortage.

Embodiment 2:

Simultaneous Use of Access Methods & Change of Access Method for Time Slot

FIG. 63 is a fragmentary block diagram showing a transmitting section of the CDMA communication unit in the radio base station. The transmitting section of this embodiment corresponds to that of FIG. 28 in the first embodiment. In this embodiment, the transmitting section includes channel coders 191a - 194d in association with a single slot (the first time slot in this example). A spread-spectrum code generator 111 is associated with these channel coders 191a - 191d. This embodiment is characterized in that the CDMA signals generated based on product information of the information codes, which are outputted from the channel coders 191a - 191d, and the spread-spectrum codes outputted from the spread-spectrum code generator 111 is assigned to the first time slot. This process is accomplished by the controller. It is accordingly possible to assign a plurality of channels to the first time slot.

According to this embodiment, since each channel coder 191a - 191d outputs an information code for every four frames, the speed of information inputs 1a, 1b, 1c, 1d is a quarter the information inputs 2, 3, 4. Namely, the information code from the channel coder 191a is outputted to the first frame of the four successive frames. Likewise, the information code from the channel coder 191b is inputted to the second frame of the four frames; the information code from the channel coder 191c is outputted to the third frame; and the information code from the channel coder 191d is outputted to the fourth frame. And to the first frame of the next four frames, the information code of the channel coder 191a is outputted. As this process is repeated, the output of any of the channel coders 191a - 191d is assigned to the first time slot. The outputs of the channel coders 192 - 194 are assigned to all of the second, third and fourth time slots of the four frames.

Thus a plurality of channels are formed in a single time slot. In this case, the transfer rate is a quarter of the transfer rate when a single channel is formed. Accordingly it is particularly useful when many channels are to be formed though not requesting a high transfer rate.

On the receiving side, by looking the information of the channel coders of FIG. 30, it is possible to identify the output of the channel coder 191a - 191d.

Embodiment 3:

FIG. 64 is a fragmentary block diagram of a transmitting section of the CDMA communication unit in the radio base station. The CDMA communication unit FIG. 64 comprises a spread-spectrum code generator 212, channel coders 191 - 194 in association with the respective information inputs 1 - 4, a generating polynomial setting unit 170 for setting a spread-spectrum code value by a given generating polynomial, and an initial value setting and final value storing unit 210 for setting an initial value of the spread-spectrum code and for temporarily storing a final value of the spread-spectrum code generated by the spread-spectrum code generator 212.

FIG. 65 shows a timing for setting a spread-spectrum code in each time slot and for storing the final value in the initial value setting and final value storing unit 210. FIG. 66 shows the interior structure of the spread-spectrum code generator 212, which is basically identical with the structure of FIG. 21 except that it transfers the final value to the initial value setting and final value storing unit 210.

This embodiment is characterized in that the single spread-spectrum code generator 212 supplies spread-spectrum codes to the channel coders 191 - 194 assigned to different time slots. Namely, the spread-spectrum code generator 212 has to generate different spread-spectrum codes to the respective channel coders 191 - 194. Therefore, as shown in FIG. 65, at the end of each burst, the final value of the spread-spectrum code generator 212 at that time is fetched, and at the same time, a generating nomial and an initial value are set at the beginning of each burst. The setting of generating nomial and initial value is already explained above in connection with the first embodiment, so any repetition of description is omitted here. The final value to be fetched from the spread-spectrum code generator 212 is each value of the respective shift register 163 in Fig 66. This final value is temporarily stored via the information channel 211.

As mentioned above, according to this embodiment, the single spread-spectrum code generator can supply different codes to the channel coders corresponding to the respective time slots. It is accordingly to assign the CDMA signal or the TDMA signal to the time slots, which are contained in the same frame, by the spread-spectrum code controller. The controller acts in such a manner that both the CDMA signal and the TDMA signal exist in the same frame.

Embodiment 4:

Setting Plural Channels in One Time Slot

FIG. 67 is a fragmentary block diagram showing a transmitting section of the CDMA communication unit in the radio base station. In this embodiment, like the foregoing embodiment, the transmitting section includes channels 191 - 193.

1 and the spread-spectrum code generator 1 is allocated to four channels, i.e., information input Nos. T1, T2, T38, T39. It is also understood that the first and third time slots are for transmission of TDMA signals while second and fourth time slots are for transmission of CDMA signals. Accordingly, if the switch 451 receives information input from the buffer memory BUF01, the other switch 452 - 454 do not receive information from the buffer memories BUF05, BUF09, BUF141 located in a position corresponding to the first time slot. This is the reason why information input No. is represented by "T*" in FIG. 70.

FIG. 72 is a timing chart showing the action of timing clocks with respect to the channel coders and the spread-spectrum code generators for every time slot. As it sends signals to all time slots one after another, the channel coder 1 is successively rendered operative. In the meantime, the spread-spectrum code generator (SS code generator) 1 is rendered operative only for the second and fourth time slots to generate CDMA signals. As is apparent from FIG. 70, the channel coders 2 - 14 and the spread-spectrum code generators 2 - 14 are rendered operative only for the second and fourth time slots, while the channel coders 15 - 36 and the spread-spectrum code generators 15 - 36 are rendered operative only for the second time slot. The setting of format to the channel coder and the setting of initial value to the spread-spectrum code generator take place within each time slot.

As mentioned above, as the CPU 445, which is control means, controls the action of the switch and the spread-spectrum code generator, it is possible to create a plurality of channels in a common time slot contained in the same transmitting frame.

Embodiment 6

Setting Plural Channels in One Time Slot

FIG. 73 is a fragmentary block diagram showing a transmitting section of the CDMA communication station in the radio base station. This embodiment is similar to the fifth embodiment except that switching-over between the output of the channel (CH) coder 191, the output of the synchronization burst generator 260 and the output of the control channel generator 261 is accomplished by a switch 456. Namely, this embodiment is a composite form combining the construction of the synchronization burst generators and the control channel generators in FIG. 38 with the construction of the fifth embodiment so that the first time slot of FIG. 34 is used as the control channel. The action of the switch 456 is controlled by the CPU 445.

FIGS. 74A and 74B are a table showing examples of combination of information input No., buffer memory No., channel coder/spread-spectrum code generator No., time slot No., information transmitting rate, transmitting type and chip rate in the radio base station of Fig. 73. It is understood from the table that the first time slot is used as the synchronization control channel in the TDMA method.

FIG. 75 is a timing chart showing the action of timing clocks with respect to the channel coders and the spread-spectrum code generators for every time slot. As shown in FIG. 75, according to this embodiment, the switch 456 selects the output of the synchronization burst generator 260 or the output of the control channel generator 261 for assignment to the first time slot. Also the switch 456 selects the channel coder 191 for assignment to the second, third and fourth times slots. Even if the switch 451 selects the buffer memory BUF01 at the time of the first time slot, the switch 456 does not select the output of the channel coder 191 so that no output is made.

On the other hand, FIG. 76 shows the transmitting section similar to that of FIG. 73, while FIGS. 77A and 77B shows an examples in which the synchronization burst/control channel assigned to the first time slot is a CDMA signal. In the CDMA method, since a plurality of channels can be created in the same common time slot in a transmitting frame, one or more other information channels in addition to the control channel can be set simultaneously in the first time slot. Accordingly, information input Nos. "T3", "T5", "T35" using the most significant buffer memories BUF05, BUF09 and BUF65 connected to the switches 452 - 454 are defined to be different from the case of TDMA signal indicated by "T*".

FIG. 78 is a timing chart showing the action of timing clocks with respect to the channel coders and the spread-spectrum code generators for every time slot. In FIG. 78, unlike the case of the TDMA signal shown in FIG. 75, it is illustrated that all of the spread-spectrum code generators are rendered operative by the first time slot.

Thus it is possible to add the other CDMA signal in the first slot is set for transmission of the CDMA signal. As shown in FIGS. 77A and 77B, as all of seventeen sets of the channel coders and the spread-spectrum code generators are used, it is possible to create fifty-two information channels in the single locus of frequency. Of course, the number of channel coders and the number of channels enabling synchronous communication should by no means limited to the illustrated example. The same thing can be said also in the following embodiments.

controller 54 of FIG. 6 changes the access method by switching over the loaded communication sections in various multi access methods or by using the loaded communication sections in various multi access methods simultaneously.

In connection with this embodiment and the following embodiments down to Embodiment 17, there are described about the changing of the access method, based on predetermined access deciding conditions, and about the setting and obtaining of necessary information for such changing.

Change of Channel based on Communication Efficiency within the Same Cell

In this embodiment, the mobile station and the radio base station, which can perform various multi access methods, shift the information channel during communication. In the illustrated example, the communication channel of the FDMA/FDD method is shifted to the TDMA/TDD method or the CDMA/TDD method. More specifically, while communication using the transmitting frequency slot 510A and the receiving frequency slot 510B in the FDMA/FDD method, PBX shifts the information channel to the TDMA/TDD method (time slots 508A, 508B) or the CDMA/TDD method (time slots 509A, 509B), which are higher in communication efficiency. This shifting procedure will now be described using FIGS. 84 and 85. The time slot in the CDMA method means a time slot which the CDMA signal is assigned to time slots of the TDMA method.

FIG. 84 is a flowchart showing the procedure of changing the access method. FIG. 85 is a block diagram of a radio system controller 41 in PBX 3. In the radio system controller 41, there are provided two memories for storing the access method deciding condition. The first memory is "mobile station's receiving level/radio base station's method information #1 memory" for storing levels of receiving radio waves from the mobile station and for storing access methods usable between the radio base station and the mobile station. The second memory is "radio station's receiving level/mobile station's method information #2 memory" for storing levels of receiving radio waves from the radio base stations and for storing access methods usable between the mobile station and the radio base station. The radio system controller 41 is equipped with a radio base station's receiving level checking unit 462 for inquiring the information stored in the #1 memory and a mobile station's receiving level checking unit 463 for inquiring the information stored in the #2 memory.

The access and modulation methods usable for the mobile station are previously stored in PSTN (public switched telephone network), or the private system, in which the mobile station is registered. If the mobile station can use the CDMA method, a spread-spectrum code also is previously stored in PSTN or the private system.

The mobile station's "usable access method & modulation method" information in the #2 memory of FIG. 85 is the information which PBX 3 requested for and received for transmission from PSTN or the private system, in which the mobile station is registered, when the mobile station makes a call and makes a position registration.

Further, when shifting to the CDMA/TDD method, it is necessary to transmit not only the frequency slot and the time slot but also a spread-spectrum code (B3247 in the example of the mobile station 5B), as indicated by the second line 465B of the mobile station 5B in "#2 memory" of FIG. 85.

The procedure of changing the information channel will now be described using the flowchart of FIG. 84.

In step 91, assume that the radio base station 4A and the mobile station 5 are talking based on the FDMA/FDD method. In this state, as indicated by the first line 464A in the first memory of FIG. 85, it is stored the fact that the radio base station 4A and the mobile station 5A are in communication using the FDMA/FDD method. Although it is able to get communication with the radio base station 4A using either the TDMA method or the CDMA method, the mobile station 5A can learn from the second and third lines 464B and 464C that they are currently in communication using that method. The radio base station 4A checks, at step 92, a vacant slot among the TDMA slots and the CDMA slots, checking whether or not a vacant channel exists. The second and third lines 464B and 464C in "#1 memory" of FIG. 85 indicate an example of results of empty channel checking. "Conform whether or not any vacant channel exists" at step 93 becomes "vacant channel exists", and the process goes to step 95. PBX confirms from "#2 memory of FIG. 85 as to whether or not the mobile station 5A currently in talking has a communication function with the TDMA method (hereinafter called "TDMA function") or a communication function with the CDMA method (hereinafter called "CDMA function").

In this embodiment, the mobile station 4A does not have, as indicated by the second 465A in "#2 memory", the CDMA function and can work only with the TDMA method. In step 96, if the judgment "TDMA exists" is made, the process goes to step 98. In step 98, PBX 3 designates the time slot of TDMA and gives to the controller 54 of the radio signal processor 30 at the radio base station 4A and the mobile station 5A instructions that their access methods be simultaneously shifted from the FDMA/FDD method to the TDMA method. Then PBX 3 recognizes that the access method has been shifted to the TDMA method, terminating the channel shifting process.

In step 96, if the judgment "CDMA exists" is made, the process goes to step 99. In step 99, the time slot of CDMA, the frequency slot and the code in use are designated, and the mobile station 5A and the radio base station 4A change the information channel using the designated information.

channel. The information to be notified from the conventional control channel are frequencies to be used merely as control channels and those to be used as information channels. Whereas this embodiment is characterized in that, in addition to the frequency to be used as the control channel and the information channel, the access method and modulation method associated with that frequency are notified. Thus, in this embodiment, the mobile station having received information in response to notification of access and modulation methods corresponding to each frequency can learn of the access and modulation methods in association of the frequency. For example, if it exists in the cell No. 110 and uses the frequency f_5 from Fig. 91 regarding the control channel, the mobile station works with the access method of CDMA/TDD and the modulation method of GMSK and can obtain information from the control channel by carrying out an access method such that the code in use is B3654-7. Further, if it exists in the cell 110 and uses the frequency f_{18} as the information channel, the mobile station works with the access method of CDMA/TDD and the modulation method of GMSK and can learn that the using code of B4654-7 needs to take access by reffering to Fig. 92.

In changing the access method during talking, the mobile station and the radio base station must obtain, via the control channel of FDMA/TDMA/CDMA, information concerning the on-the-other-end station's usable access method other than the access method currently in use for talking.. The digital TDMA/CDMA method is easy to create a slow associated control channel (SACCH) through which either the mobile station or the radio base station can obtain, during talking, the information concerning usable access methods of the station on the other end via SACCH. Even in the case of FDMA/FDD (FM), it is possible to obtain, during talking, the information concerning usable access methods of the station on the other end in out-of-voice-band tone FSK (e.g., 150Hz/200Hz of tone FSK).

This embodiment relates to a mobile communication system workable with a plurality of access methods and is equipped with control channels dedicated one for each access method. However, in this embodiment, if the mobile station makes a call to the radio base station using an access method, liking is accomplished in that access method. Otherwise, if none of the channels usable with the called access method is vacant, linking is accomplished using an empty channel of another multi access method.

Embodiment 12

Process for Registering Position of Mobile Station

The process of registering the position of the mobile station according to this embodiment will now be described.

FIG. 93 is a block diagram showing the mobile communication system when a request for position registration is made. A mobile station information center 466 is connected to PSTN 1. The mobile station information center 466 previously stores a personal system No. (PS No.) for identifying the mobile station 5B and usable access and modulation methods of the mobile station 5B. In PBX 3, a position registration calling unit 42 is located as shown in FIG. 5. The position registration calling unit 42 is equipped with a position registration processor 467, and a memory 468 for storing information of the mobile station. The memory 468 of FIG. 94 is a storage for storing access method deciding conditions and stores information of the mobile station which requests position registration. For example, if the mobile station 5B of FIG. 93 makes a request for position registration, PBX 3 requests the mobile station information center 466 for the mobile station information, based on the mobile station's PS No. PS064971. This information is stored in PBX 3 in the format of FIG. 94. With the information previously stored in PBX 3, if the mobile station has made a calling-out, or if the mobile station has received a paging from another mobile station within PSTN or the private system, it is possible to save time to inquire to the mobile station information center 466 connected again to the PSTN, thus avoiding temporary overlay of inquiries. If either the mobile station or the radio base station can selectively use a plurality of kinds of access methods, it is necessary to learn what access methods are usable with the station on the other end. In this example, by registering the access and modulation methods of the mobile station previously in the mobile station information center 466 and downloading the information concerning the mobile station's access and modulation methods from the mobile station information center 466 during the process of registering the mobile station in each PBX 3, it is possible to anticipate the information concerning possible mobile stations that are connectable to the PBX 3.

Accordingly, in this embodiment, since usable access methods are previously stored in a memory 468, it is possible to effectively decide an access method between the mobile station and the radio base station, based on the registered information.

Embodiment 13

Deciding Communication channel

The procedure for establishing a link between the mobile station and the radio base station according to this embodiment will now be explained. FIG. 95 shows a mobile communication system of the thirteenth embodiment in which, like the previous embodiment, is equipped with a mobile station information center 466. FIG. 96 is a flowchart of link level

PS092373) will now be described using the case shown in FIG. 97. The mobile station 5A (PS064971) of FIG. 97 is wirelessly connected with the radio base station 4A via the communication channel 17 according to the TDMA method. Assuming that the charging usage up to a fixed telephone apparatus 7 with the channel efficiency of 1.0 is yen 1 yen per second, the total charge for the talking time of 120 seconds stored in the information memory 470 is as follows:

$$\text{Charge of PS064971 for 120 sec.} = 120 \times 0.73 = 87.6 \text{ yen} \qquad \text{(Equation 8.4)}$$

Likewise the respective charges for the mobile stations 5B (PS034673) and 5C (PS092373) are as follows:

$$\text{Charge of PS034673 for 55 sec.} = 55 \times 1.0 = 55.0 \text{ yen} \qquad \text{(Equation 8.5)}$$

$$\text{Charge of PS092373 for 440 sec.} = 440 \times 0.36 = 158.4 \text{ yen} \qquad \text{(Equation 8.6)}$$

In these examples, the charging usage are calculated with consideration of the channel efficiency.

This embodiment is characterized by an exchange having a function of calculating the channel efficiency to be evaluated from various access methods, modulation methods, voice coding rate and spread-spectrum coding rate and to be discriminated from the occupied spectral width on the radio frequency axis and the time slot width on the time axis, with respect to the channel in talking.

The mobile communication system of this embodiment is characterized in that priorities are assigned to the usable access methods based on the channel efficiency.

Namely, while the mobile station and the radio base station are in talking in one multi access method among various multi access methods, it is possible to change the multi access method to a higher-efficiency method, based on the calculated channel efficiency, if a usable vacant channel is detected among the time slot assigned to the multi access method that the mobile station and the radio base station can use within the cell in talking.

Embodiment 15

Calculation of Channel Reliability

FIG. 100 shows an example of accounting system with consideration of channel reliability. FIG. 101 is a block diagram showing a system recognition unit 55 of PBX (exchange) 3.

The exchange 3 for the mobile communication system of this embodiment is equipped with a radio channel priority selecting mechanism in order to select the radio channel in association with the channel reliability and the charging usage according to the subscriber's request, for the mobile station and the radio base station corresponding to at least one multi access method and at least one modulation method. Specifically, the exchange 3 includes a private protocol radio base station processor 39 and a public protocol radio base station processor 40 for processing signals in the private and public systems. The exchange 3 further includes the system recognition unit 55 for selecting any one of the systems, a radio system controller 41 for performing a handover sequence process and a receiving level inquiry, a position registration calling unit (not shown), and a network interface processor 43. The construction of PBX 3 is shown in FIG. 5. In FIG. 101, additional information concerning the channel reliability is stored in the information memory 470.

Assuming that the system is in communication using the FDMA method, if the exchange transmits a channel reliability measuring request to the mobile station via the radio base station, the mobile station in voiceless state stops transmitting through part of a voice information section or data section in the transmitting time slot in 1 frame, or stops transmitting throughout 1 frame. The radio base station measures a background noise signal intensity in the frame, i.e. the time slot free of transmitting output from the mobile station, or in part of transmitting stop section of the transmitting section, and reports to the exchange of the measured value and an intensity measured value of the signal being transmitted from the mobile station. The exchange calculates a signal-to-interference-wave-and-noise ratio from these two measured values and also calculates a channel reliability from this ratio.

Assuming that the system is in communication using the TDMA method or the CDMA method, if the exchange transmits a channel reliability measuring request to the mobile station via the radio base station, the mobile station in voiceless state stops transmitting through part of the voice information section or data section in the transmitting time slot in 1 frame, or stops transmitting throughout 1 frame. The radio base station measures a background noise signal intensity in the frame, i.e. the time slot free of transmitting output from the mobile station, or in part of transmitting stop section of the transmitting time slot, and reports to the exchange of the measured value and an intensity measured value of the signal being transmitted from the mobile station. The exchange calculates a signal-to-interference-wave-and-noise ratio from these two measured values and also calculates a transmission error rate of the channel with consideration of the modulation method in use. The larger the interference wave, the higher the transmission error rate becomes increased. Consequently, the exchange of this embodiment is characterized by the function of calculating the channel reliability from the transmission error rate so that the reliability of the channel is set to a high level.

that the user accepts the low channel reliability, PBX 3 can select the channel, by the information memory 470, in such a manner that the charging usage is reduced to a minimum according to Equation 9.3, by previously registering in a priority assignment column 470b that priority is assigned to the channel discount like the mobile station having PS No. PS092373 of FIG. 105. The mobile station having PS No. PS064971 is registered as "ordinary" 470c in the priority assignment column 470b, not being specially designated to have a priority assignment.

FIG. 106 is Table 5 showing methods selected by three mobile stations of FIG. 105. Table 5 of the FIG. 106 shows a registration list of priorities assigned to the access methods as the result of consideration of priority assignment to each mobile station. The mobile station PS064971 at the first line 470c in FIG. 105 is registered as "ordinary" in priority assignment and therefore selects the TDMA/TDD method of the priority 1 with respect to PS046971 from FIG. 106. The mobile station PS034673 at the second line 470d in FIG. 105 is registered with the top priority assigned to "reliability", and therefore decides the access method based on the value of "channel reliability". In FIG. 106, the FDMA/FDD method is selected. The mobile station PS092373 at the third line 470e in FIG. 105 is registered with the top priority assigned to "channel discount", and therefore selects the access method whose charging usage is reduced to a minimum. In FIG. 106, the CDMA/TDD method is selected.

FIG. 107 is a flowchart showing the above-mentioned selecting procedure. The selecting procedure of FIG. 107 is a process to be performed by the system recognition unit 55 of PBX 3. The system recognition unit 55 performs the priority assignment setting procedure of FIG. 107 for every mobile station according to the information of priority assignment column 470b in the information memory 470. In step 320, the priority process is started. In Step 321, it is discriminated as to whether or not the mobile station has a priority to the reliability. If "YES" as the result of discrimination as to whether or not it is the reliability priority process, discrimination is made, in step 322, as to whether or not the priority has been registered on the registration list of FIG. 106. If it is already registered in the registration list, the method is selected according to the registration list in step 323. In the absence of such registration in the registration list, the reliability of the respective method is estimated and calculated, in step 324, as described in the fifteenth embodiment. In step 324, if the method having the maximum reliability is selected, the said method is previously registered in the registration list such as of Table 5.

Assuming that "channel discount" has a priority over "reliability", if it is judged in step 325 that "channel discount" has a priority, discrimination is made in step 326 as to whether or not the priority to "channel discount" is already registered in the registration list of FIG. 106. If it is already registered in the registration list, the method is selected according to the registration list in step 327. In the absence of such registration in the registration list, the charges of the individual available methods of FIG. 106 are calculated and compared according to Equation 9.3 of the fifteenth embodiment, thus selecting the most inexpensive method.

As mentioned above, according to this embodiment, in the system in which the channel efficiency is evaluated from various access methods, modulation methods, voice coding rate and spread-spectrum coding rate and is judged from the occupied spectrum width on the radio frequency axis and the occupied time slot width on the time axis, the larger the interference wave from the slot other than the frequency slot/time slot of the FDMA method or of the TDMA method, the higher the transmission error rate. Therefore, the reliability of the channel is set to a low value, and a discount rate of the charging usage is decided commensurate with the degree of deterioration of the channel reliability due to the increase of the transmission error rate.

Further, if there are within the same CDMA circuit subscribers using various mutually orthogonal codes, or if subscribers more than the limit get communication within the same CDMA circuit, a discount rate of the charging usage commensurate with the degree of deterioration of the channel reliability of the talking.

The subscriber hoping to use the channel with a discount rate as large as possible can be previously registered in a subscriber information memory of the exchange. The exchange is characterized by the function of selecting the channel for use so as to lower the charging usage, using such information in registration. The exchange is also characterized by a channel selection priority assigning function for performing the channel selection with priority to the channel of the subscriber having started talking earlier

Embodiment 17

Selection of Access Method Based on Priority Assignment (Channel Quality)

This embodiment deals with the linking for the mobile station hoping the channel whose quality is as high as possible. The priority-to-reliability assigning procedure is carried out in steps 322 and 324 in FIG. 107.

The mobile station PS034673 of FIG. 105 is an example of user with priority to the channel reliability (hereinafter called "priority-to-reliability user"), and "reliability" 470d is registered in the priority assignment column 470b. FIG. 108 shows an actual example in which PBX sets the channel reliability. When the priority-to-reliability user selects the TDMA method, it selects the time slot, which is small in number of slots occupied, among T3/R3 of the same time slots 518A and 518B, like the slots 517A and 517B of FIG. 108. If the priority-to-reliability user uses the CDMA method, it is possible

According to this embodiment, the mobile station or the radio base station in communication in the FDMA multi access method measures the intensity of signal in talking and measures background noise during voiceless state. By these measured values, then the mobile station or the radio base station calculates a signal-to-noise-and-interference-wave ratio, and judges whether or not the evaluation value is smaller than a predetermined value. Or in a system continuously monitoring the error rate of FM-out-of-band tone (e.g., 150Hz or 25Hz) FSK digital information, the mobile station or the radio base station judges whether or not the error rate is smaller than a predetermined value. Or during voiceless state, the mobile station or the radio base station transmits and receives the TDMA signal, measures the error rate and judges whether or not the error rate is smaller than a predetermined value. Or during voiceless state, the mobile station or the radio base station transmits and receives the CDMA signal, measures the error rate and judges whether or not the error rate is smaller than a predetermined value.

Assuming that the exchange used any one of the above-mentioned functions, if it turns out that the error rate is smaller than a predetermined value, the exchange judges that hand-of to the adjacent cell is needed. Or assuming that the exchange uses a predetermined number of functions among the above-mentioned functions, if it turns out that the error rate is smaller than a predetermined value, the exchange judges the necessity of hand-off to the adjacent cell.

Embodiment 19

Judgment of Whether or not Hand-Off is need (TDMA)

In this embodiment, hand-off judgment during TDMA talking, namely, during communication using the TDMA method will now be described. One example will be explained in which while the mobile station is wirelessly connected with the radio base station in the TDMA method, the mobile station approaches near the border of the cell.

FIG. 110 is a flowchart showing the procedure of judging whether of not hand-off is needed during communication according to the TDMA method. In the flowchart of FIG. 110, firstly the error rate of the TDMA digital signal now in talking is measured (step 350). If the measured value is smaller than a predetermined value, a judgment is made that hand-off is needed (step 351).

Further; using the time slots (e.g., time slots 520A/520B of the CDMA method in FIG. 108) other than the time slot (e.g., time slot 517A/517B in FIG. 108) according to the TDMA method during talking, CDMA signals are transmitted and received, and an error rate of the digital information is measured and evaluated (step 353), and a judgment of hand-off is done (step 354).

As it assumes a voiceless state during talking according to the TDMA method, the FDMA signal is transmitted while it stops transmitting the TDMA signal, and a signal-to-interference-wave-and-noise ratio of the FM voice wave is measured (step 356), and a judgment is made whether or not hand-off is needed (step 357).

In this case, a voiceless state of FM voice is necessary when measuring the interference-wave-and-noise. If the voice continuous state runs, an error rate of FM-out-of-band tone FSK digital signal is measured and evaluated (step 359), and an judgment is made whether or hand-off is needed (step 360). In FIG. 110, the results of judging as to whether or not four kinds of hand-off in steps 351, 354, 357, 360 are needed are evaluated in step 364. Further, in step 365, an judgment is made whether or not hand-off has to be done.

The evaluation of results of the hand-off judgment in step 364 may be carried out in the following manner:

(1) If a message is received that any one or more judgments of the above-mentioned four judgments need hand-off, then soon such hand-off to the adjacent cell (of the present system or of the adjacent system) is done.
(2) Only if a message is received that two or more judgments of the above-mentioned four judgments need hand-off, such hand-off to the adjacent cell (of the present system or of the adjacent system) is done.

The weighting of evaluation to do hand-off may be accomplished by various methods other than the above-mentioned (1) and (2) when a message that every hand-off is needed.

As is mentioned above, in this embodiment, as during communication in the TDMA method, it is possible to judge, by using another access method, whether or not hand-off is needed.

According to this embodiment, the mobile station or the radio base station in communication in the TDMA multi access method measures the intensity of signal in talking and measures background noise during voiceless state. By these measured values, then the mobile station or the radio base station calculates a signal-to-noise-and-interference-wave ratio, and judges whether or not the evaluation value is smaller than a predetermined value. Or in a system continuously monitoring the error rate of FM-out-of-band tone FSK digital information, the mobile station or the radio base station judges whether or not the error rate is smaller than a predetermined value. Or during voiceless state, the mobile station or the radio base station transmits and receives the TDMA signal, measures the error rate and judges whether or not the error rate is smaller than a predetermined value. Or during voiceless state, the mobile station or the radio base station transmits and receives the CDMA signal, measures the error rate and judges whether or not the error rate is smaller than a predetermined value.

Embodiment 21

Change of Access Method at Hand-off

FIG. 112 is a flowchart showing the procedure of hand-off to the adjacent cell. If a decision is made of the necessity of hand-off to the adjacent system or to the cell adjacent to the system according to the procedure of FIGS. 109, 110 and 111.

Table 6 of FIG. 113 shows control channel information of the adjacent system. Table 7 of FIG. 114 shows information channel information of the adjacent system. The control and information channels of the adjacent cell are stored in the memory of PBX 3 as shown in Tables 6 and 7.

The procedure of hand-off will now be described according to the flowchart of FIG. 112.

In step 401, when hand-off to the adjacent system is designated, it is confirmed in step 402 as to whether or not the mobile station, which performs hand-off, is included in the usable method in the adjacent system. This confirmation is made based on Tables 6 and 7 in the memory of PBX. In step 403, if it is confirmed that the mobile station can perform any one method of the usable methods of the adjacent system, in step 405 PBX notifies the adjacent radio base station that the mobile station will be handed off and designates the acceptance of the access from the mobile station. The adjacent radio base station checks, based on the notification from PBX 3, whether or not the designated method is usable and whether or not a vacant channel of the said method exists. In the adjacent radio base station, if they are confirmed, the result is notified to PBX. In step 406, PBX checks, based on the checking result, as to whether or not the acceptance of hand-off is done. In step 408, PBX reports to the mobile station, via the radio base station in talking, of information such as access and modulation methods to be used in the adjacent radio base station. The radio base station designates the mobile station to shift the talking to the adjacent radio base station at a specified timing, using the control channel. The mobile station shifts the talking to the adjacent radio base station based on the designation.

As mentioned above, according to this embodiment, if it is judged that the mobile station has to be handed off to the adjacent cell within the system or needs roaming to the adjacent cell of the adjacent system while the mobile station and the radio base station are in talking in one multi access method among plural multi access methods, it is possible to inherit the same access method to perform hand-off and at the same time to change the access method to another method at the time of hand-off.

Embodiment 22

Change of Access Method at Hand-Off with Priority

The hand-off procedure with priority to the adjacent cell.

FIG. 115 is a flowchart of the hand-off procedure with priority to the adjacent cell. FIG. 115 is similar to FIG. 112 except that step 420 is added. The details of step 420 is shown in FIG. 116.

FIG. 116 is a flowchart of the priority assigning process of FIG. 115, showing the procedure in which a single access method among a plurality of access methods is set, with the priorities assigned, in the same manner of FIG. 107. As shown in FIG. 116, the priority is exemplified by two cases: (1) priority is assigned to the reliability; and (2) priority is assigned to the channel discount. In the example (1), an access method such that the channel reliability will be maximal is selected as shown in steps 321 - 324. On the other hand, in the example (2), an access method such that the charging usage will be minimal is selected as shown in steps 325 - 328.

Thus, even when the mobile station is handed off to the adjacent system, it is possible to select an access method, among a plurality of access methods with priorities assigned to them, to meet its priority.

This embodiment is applicable to a system in which a channel efficiency is discriminated from the occupied spectrum width on the radio frequency axis and the occupied time slot width on the time axis and is also evaluated from the access methods, modulation methods, voice coding rate and spread-spectrum coding rate. The larger the interference wave from the slot other than the frequency slot/time slot of the FDMA method or the TDMA method, the higher the transmission error rate. Consequently, in this embodiment, the channel reliability is set to low so that a discount rate of the charging usage is decided or determined commensurate with the degree of deterioration of channel reliability due to the increase of the transmission error rate.

Further, if there are subscribers currently using many mutually orthogonal codes within the same CDMA circuit, and if subscribers exceeding a limited number are got in communication within the same CDMA circuit, a discount rate of the charging usage is decided or determined commensurate with the degree of deterioration of the channel reliability of the talking.

As mentioned above, since the access method is changed according to the priority, it is possible to perform a quick and exact hand-off.

When handing off to the adjacent cell, the subscriber hoping to use the channel with a discount rate as high as possible can be previously registered in a subscriber information memory of the exchange. The exchange of this embod-

Assume that the mobile station 5A goes gradually away from the coverage of the radio station 6 and enters the coverage of the radio base station 4A of the private system while communicating firstly with the radio base station 6 of the public system by the slot No. 2 (483) in FIG. 123. In this case, the mobile station 5A is able to be connected with the first slot 484 or the fourth slot 485, which are communicable in a predetermined access method, i.e. in this case the same CDMA method. The timing point for switchover connection is illustrated in FIG. 126.

Any of the first and fourth time slots has to be decided as the destination-of-switchover time slot. In this embodiment, it is decided based on "number of simultaneous talking CHS" of FIG. 123. Namely, in FIG. 124, since the slot No. 1 (484) has 7 channels occupied while the slot No. 4 (485) has 31 channels occupies, it is preferably to use the first time slot whose number of occupies channels is smaller. Accordingly, the mobile station 5A (mobile station No. 101) continues talking with the radio base station 4A, using the first slot.

Thus, according to this embodiment, a channel may be created with consideration of the load of additional radio base station to be connected, consulting the number continuous channels in each time slot.

In this embodiment, the destination-of-switchover deciding condition is the number of simultaneous channels; however, this invention should by no means be limited to this illustrated example.

As mentioned above, in the foregoing embodiments, various mobile communication systems are shown. Some of these embodiments deal with a combined construction of the individual embodiments. Various other combination may be suggested without departing from the spirit of this invention.

Claims

1. A mobile communication system which includes a mobile station and radio base stations for performing wireless communication between said stations using a predetermined method selected from a number of multiple access methods, wherein each of said stations comprises:

   (a) TDMA communication means for assigning TDMA signals to time slots, which are contained in a frame, to perform communication based on a TDMA method; and
   (b) CDMA communication means having at least one spread-spectrum code generator and adapted for communication of CDMA signals based on a CDMA method;
   (c) said CDMA communication means being adapted for assigning spread-spectrum codes, which are generated by said spread-spectrum code generator, to said time slot.

2. A mobile communication system which includes a mobile station and radio base stations for performing wireless communication between said stations using a predetermined method selected from a number of multiple access methods, wherein each of said stations comprising:

   (a) TDMA communication means for assigning TDMA signals to time slots, which are contained in a frame, to perform communication based on a TDMA method; and
   (b) CDMA communication means having a spread-spectrum code generator, which generates a number of spread-spectrum codes, and adapted for communication of CDMA signals based on a CDMA method;
   (c) said CDMA communication means being adapted for assigning different spread-spectrum signals, which are generated by said spread-spectrum code generators, respectively to said time slots.

3. A mobile communication system which includes a mobile station and radio base stations for performing wireless communication between said stations using a predetermined method selected from a number of multiple access methods, wherein each of said stations comprising:

   (a) TDMA communication means for assigning TDMA signals to time slots, which are contained in a frame, based on a TDMA method; and
   (b) CDMA communication means having a number of spread-spectrum code generators, which generate different spread-spectrum codes, and adapted for communication of CDMA signals based on a CDMA method;
   (c) said CDMA communication means being adapted for assigning said different spread-spectrum signals, which are generated by said spread-spectrum code generators, respectively to said time slots.

4. A mobile communication system which includes a mobile station and radio base stations for performing wireless communication between said stations using a predetermined method selected from a number of multiple access methods, wherein each of said stations comprises:

   (a) TDMA communication means for assigning TDMA signals to time slots, which are contained in a frame, to perform communication based on a TDMA method;

information, and said spread-spectrum code generator for generating different spread-spectrum codes one for each of said time slots, and wherein said control means assigns the CDMA signals generated based on product information of an output of each said channel coder and each said spread-spectrum code to said time slots to assign a number of channels to one of said time slots.

13. A mobile communication system according to claim 12, wherein said control means sets a number of said channels of the same access method for the same time slot.

14. A mobile communication system according to claim 4, wherein said mobile station has receiving-state detecting means for detecting a state of receiving signals from a number of said radio base stations, and said control means sets, based on the detected state of receiving, a separate channel between said mobile station and another radio base station using a time slot different from the time slot presently occupied by said channel.

15. A mobile communication system according to claim 1, wherein said CDMA communication means has means for generating empty time slot.

16. A mobile communication system according to claim 1, wherein said CDMA communication means has a initial value setting unit for arbitrarily setting an initial value of the spread-spectrum code generated by each said spread-spectrum code generator.

17. A mobile communication system which includes a mobile station and radio base stations for performing wireless communication between said stations using a predetermined method selected from a number of multiple access methods, wherein each of said stations is loaded with a spread-spectrum code generator for generating a number of spread-spectrum codes and has a noncoherent delay lock loop for detecting the spread-spectrum code assigned to the CDMA signal contained in each time slot received based on the TDMA method.

18. A mobile communication system according to claim 17, wherein said CDMA communication means has a spread-spectrum code value setting unit for arbitrarily setting a value of the spread-spectrum code, which is generated by said spread-spectrum code generator, by a generating polynomial

19. A mobile communication system according to claim 18, wherein said spread-spectrum code value setting unit has a group of switches for freely changing a feedback loop including a shift register.

20. A mobile communication system according to claim 1, wherein said CDMA communication means has a spread-spectrum code value setting unit for arbitrarily setting a value of the spread-spectrum code, which is generated by said spread-spectrum code generator, by a generating polynomial.

21. A mobile communication system according to claim 20, wherein said spread-spectrum code value setting unit has a group of switches for freely changing a feedback loop including a shift register.

22. A mobile communication system according to claim 4, wherein said CDMA communication means has a chip clock control unit for controlling a chip clock of said spread-spectrum code generator.

23. A mobile communication system according to claim 4, wherein said CDMA communication means has a chip rate control unit for controlling a chip rate of said spread-spectrum code generator.

24. A mobile communication system according to claim 4, wherein each said station has a carrier frequency control unit for controlling a carrier frequency of each time slot.

Fig.1

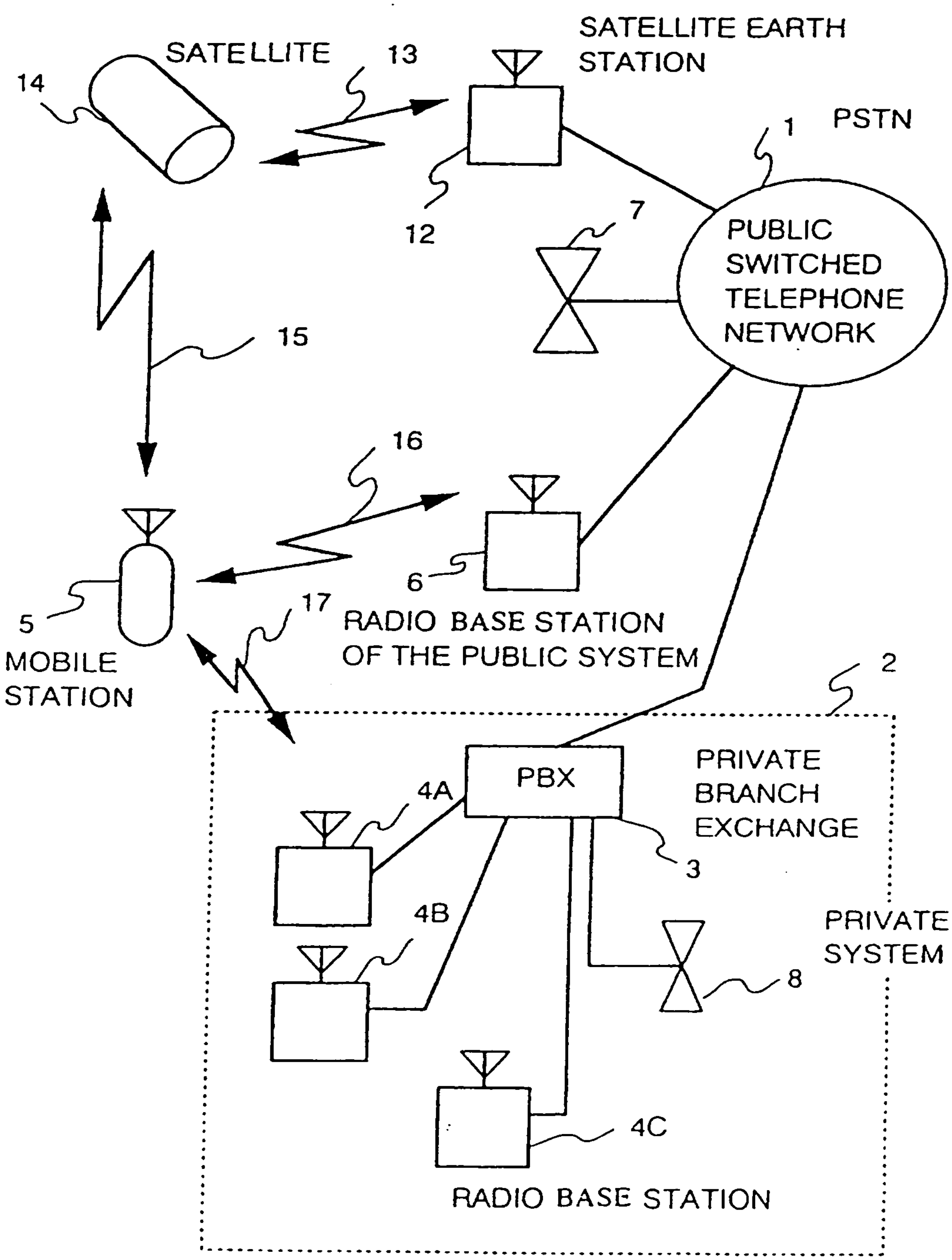
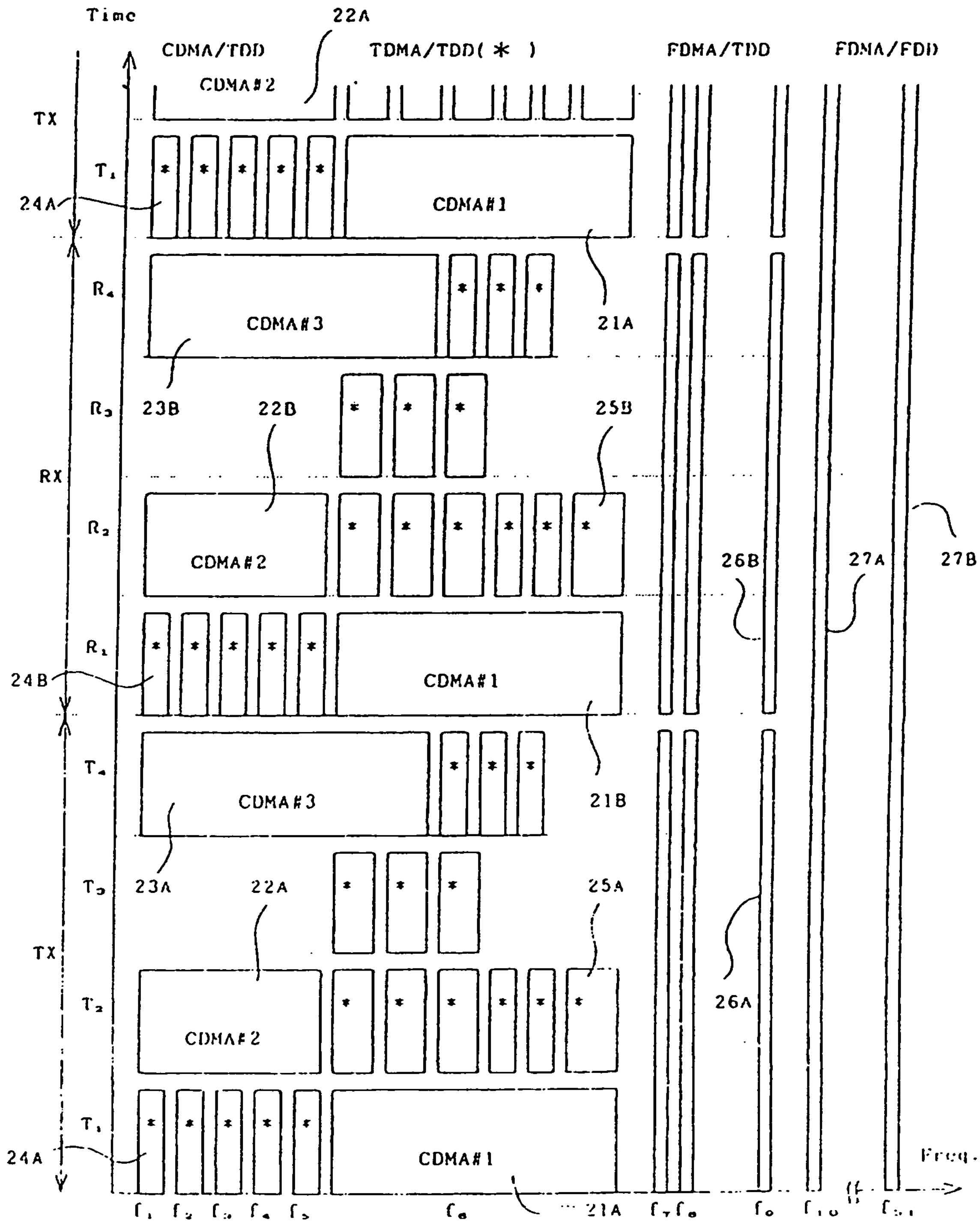

SATELLITE
14
13
SATELLITE EARTH
STATION
12
1
PSTN
PUBLIC
SWITCHED
TELEPHONE
NETWORK
7
15
16
6
5
MOBILE
STATION
17
RADIO BASE STATION
OF THE PUBLIC SYSTEM
2
PBX
PRIVATE
BRANCH
EXCHANGE
3
4A
4B
PRIVATE
SYSTEM
8
4C
RADIO BASE STATION

Fig.2



RELATIONSHIP BETWEEN TIME SLOT

AND OCCUPIED FREQUENCY

Fig.3

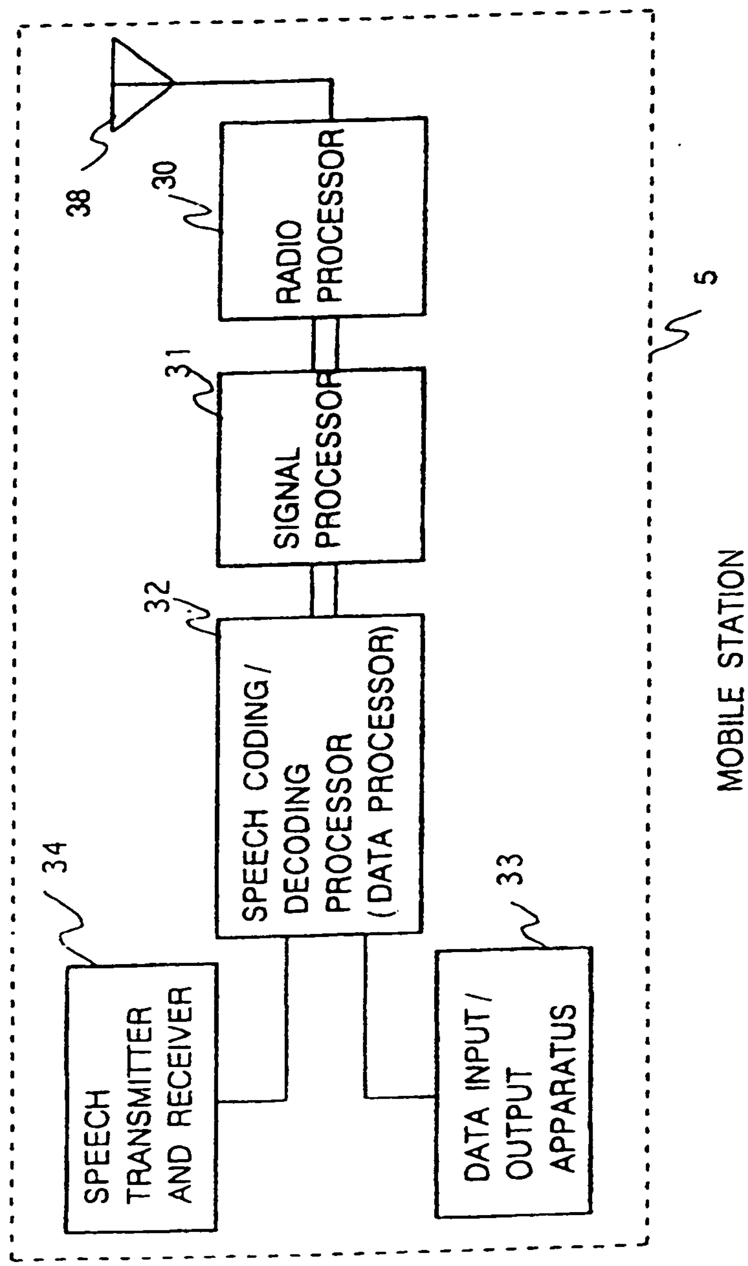
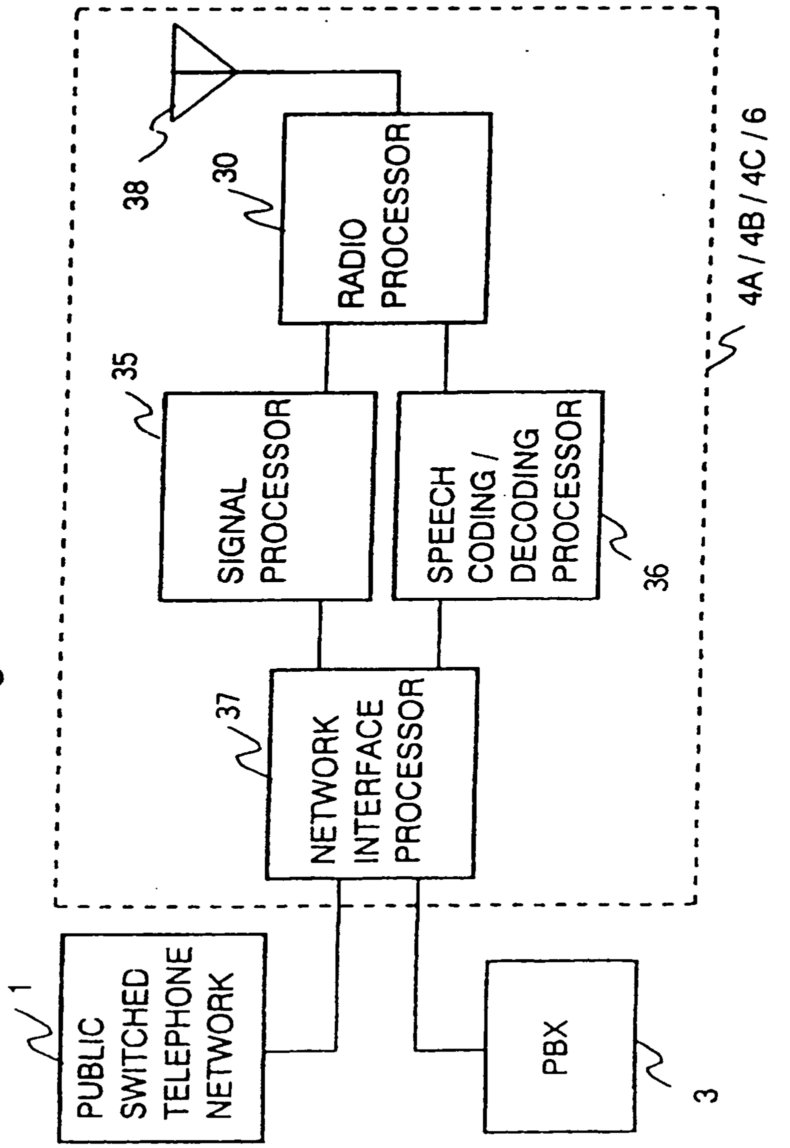

38
30
RADIO PROCESSOR
31
SIGNAL PROCESSOR
32
SPEECH CODING / DECODING PROCESSOR (DATA PROCESSOR)
34
SPEECH TRANSMITTER AND RECEIVER
33
DATA INPUT / OUTPUT APPARATUS
5
MOBILE STATION

Fig.4



RADIO BASE STATION

Fig.5

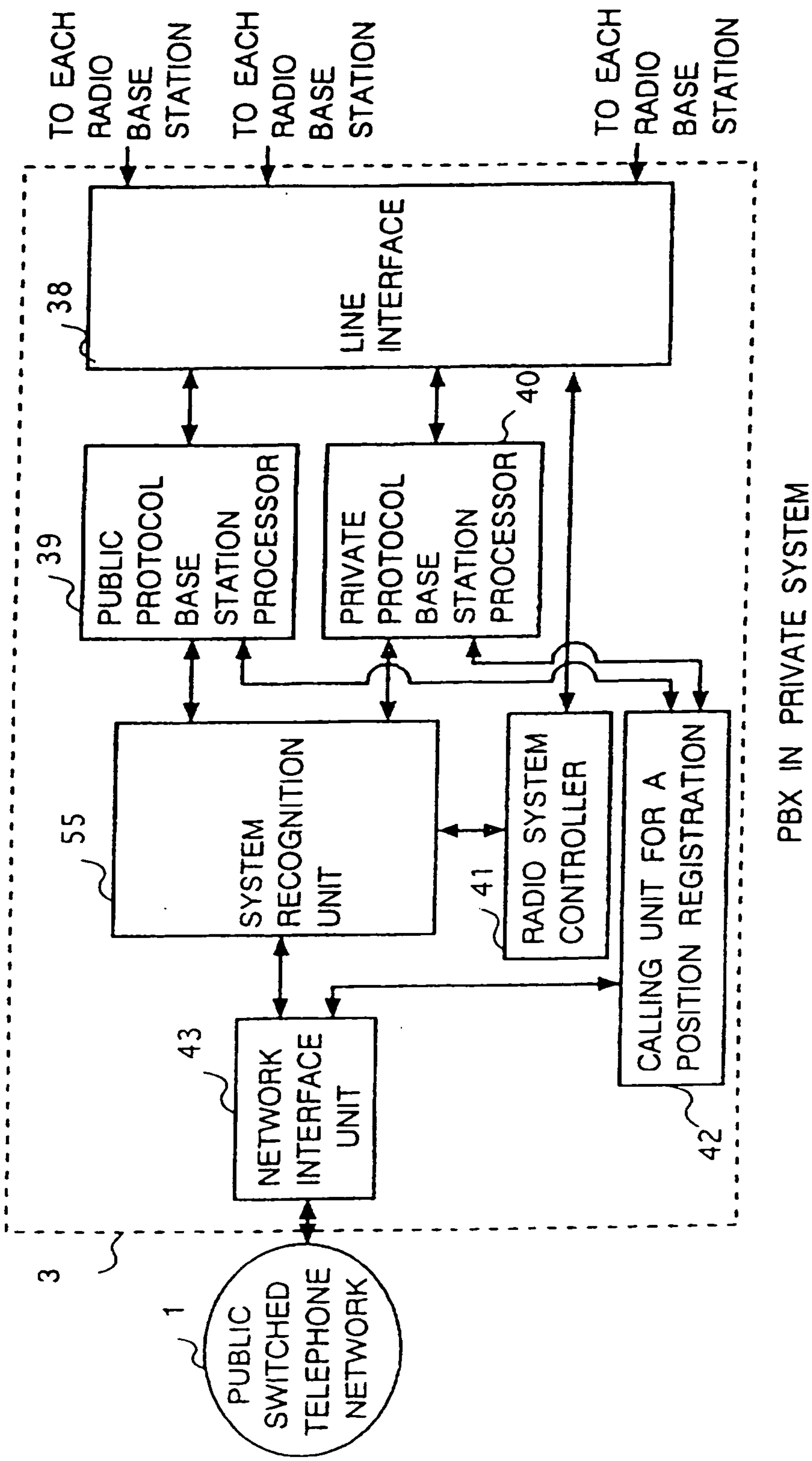

TO EACH RADIO BASE STATION
TO EACH RADIO BASE STATION
TO EACH RADIO BASE STATION
38
LINE INTERFACE
39
PUBLIC PROTOCOL BASE STATION PROCESSOR
40
PRIVATE PROTOCOL BASE STATION PROCESSOR
55
SYSTEM RECOGNITION UNIT
41
RADIO SYSTEM CONTROLLER
CALLING UNIT FOR A POSITION REGISTRATION
42
43
NETWORK INTERFACE UNIT
3
1
PUBLIC SWITCHED TELEPHONE NETWORK
PBX IN PRIVATE SYSTEM

Fig. 6

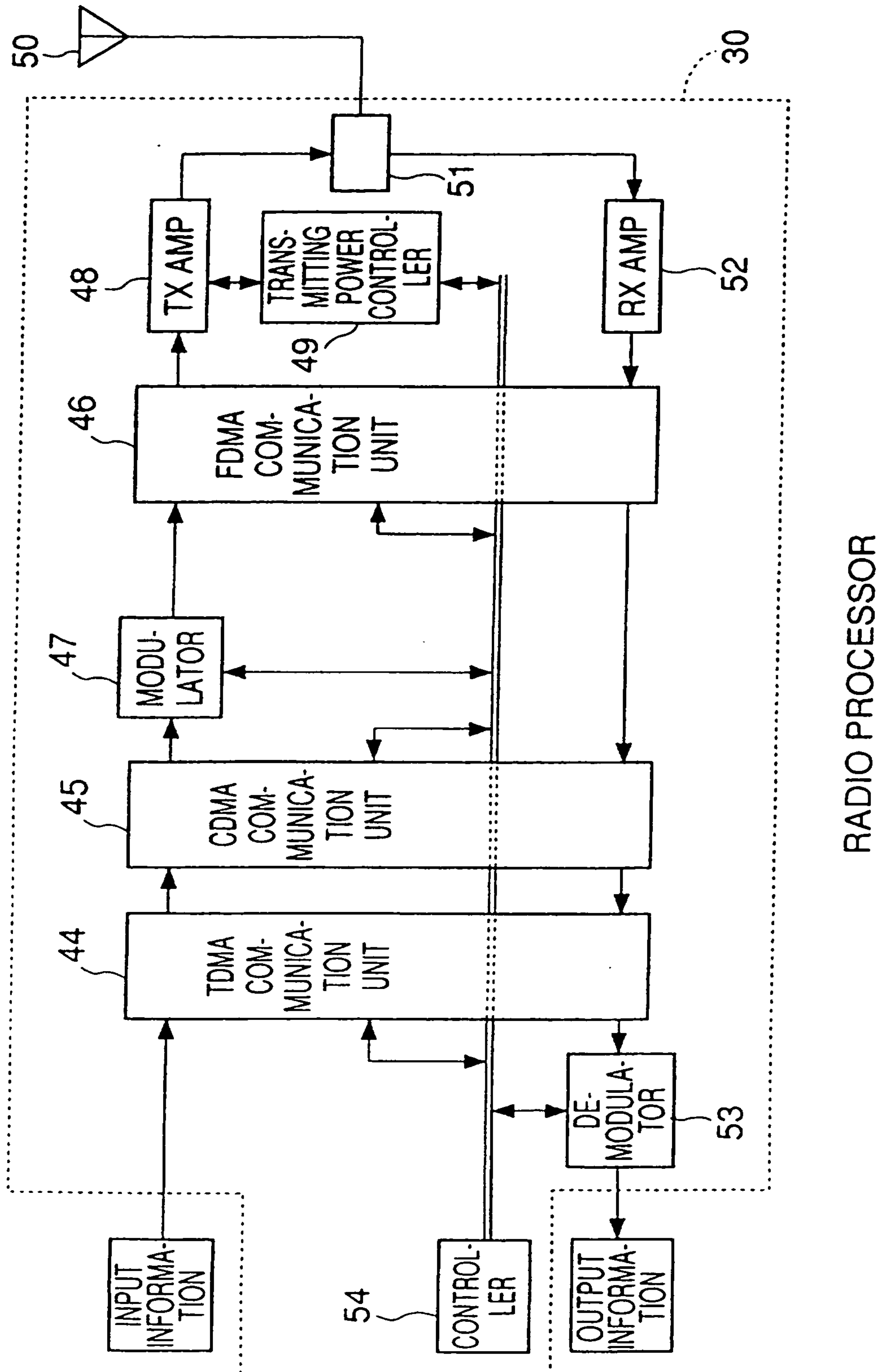

50
30
51
TX AMP
48
TRANS-
MITTING
POWER
CONTROL-
LER
49
RX AMP
52
FDMA
COM-
MUNICA-
TION
UNIT
46
MODU-
LATOR
47
CDMA
COM-
MUNICA-
TION
UNIT
45
TDMA
COM-
MUNICA-
TION
UNIT
44
DE-
MODULA-
TOR
53
INPUT
INFORMA-
TION
CONTROL-
LER
54
OUTPUT
INFORMA-
TION
RADIO PROCESSOR

Fig. 7

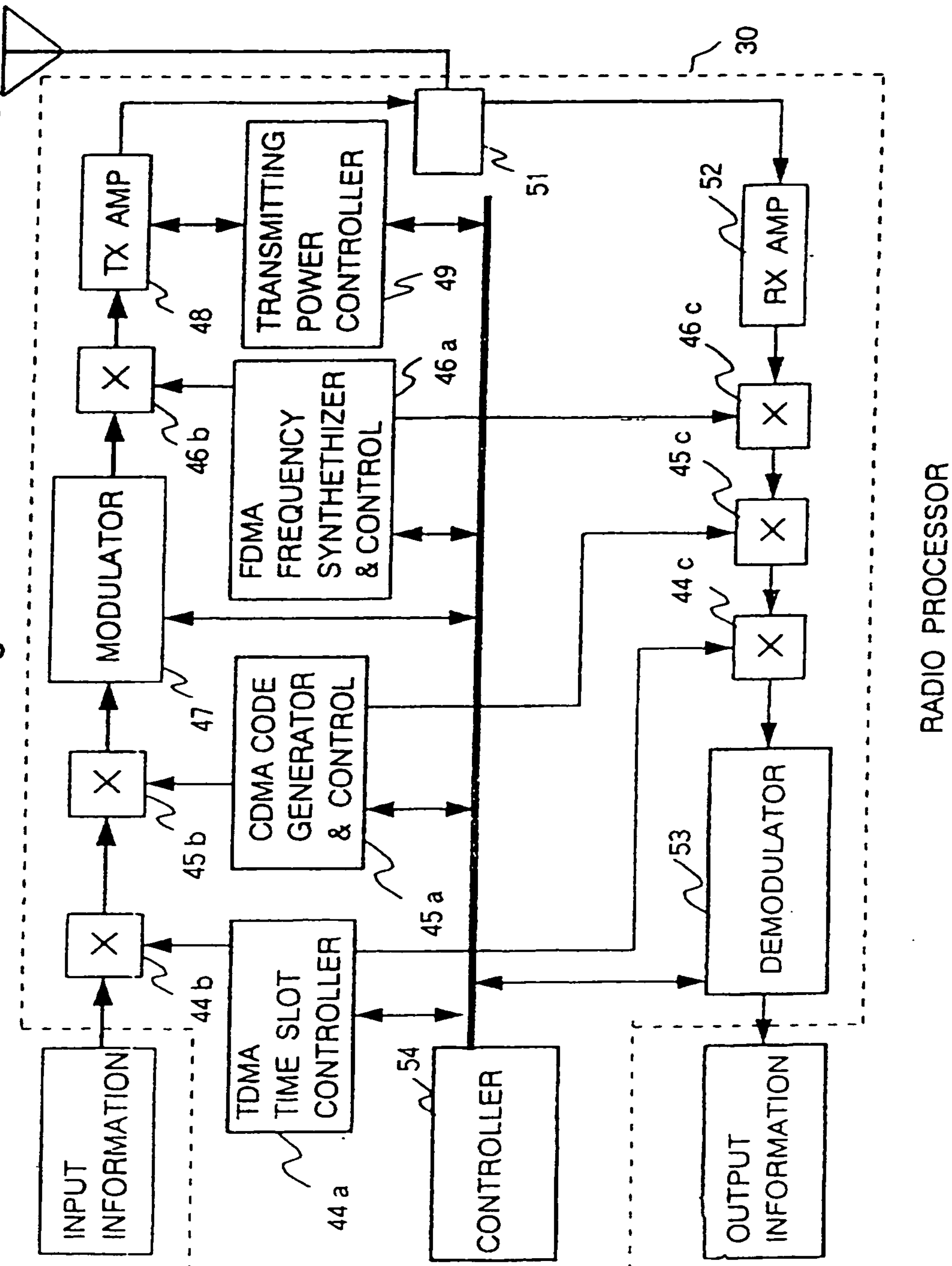
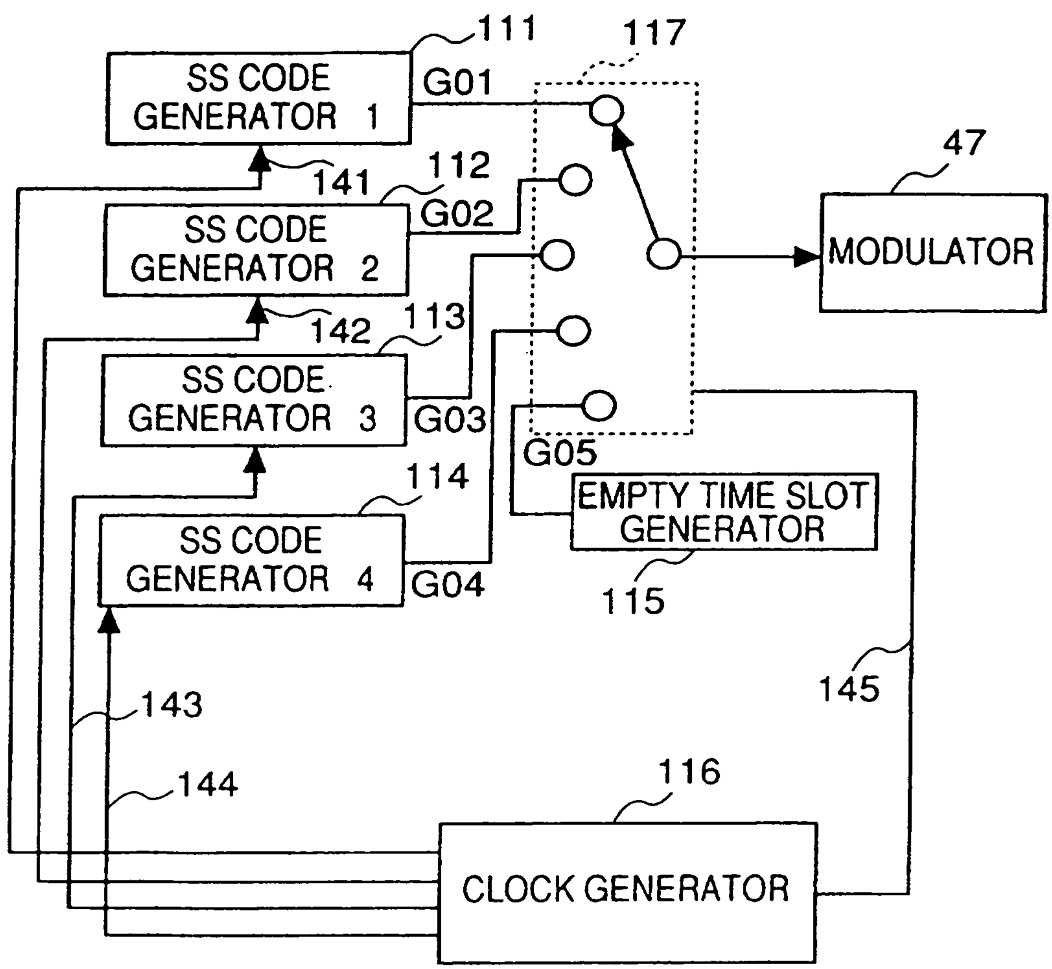

50
30
TX AMP
TRANSMITTING POWER CONTROLLER
51
52
RX AMP
48
49
46 a
46 c
46 b
FDMA FREQUENCY SYNTHETHIZER & CONTROL
45 c
MODULATOR
44 c
47
CDMA CODE GENERATOR & CONTROL
RADIO PROCESSOR
45 b
45 a
53
DEMODULATOR
TDMA TIME SLOT CONTROLLER
44 b
54
INPUT INFORMATION
CONTROLLER
44 a
OUTPUT INFORMATION

Fig. 8



RADIO BASE STATION MODEL WITH SPRED-SPECTRUM CODE GENERATORS ASSOCIATED WITH TIME SLOTS

Fig. 9

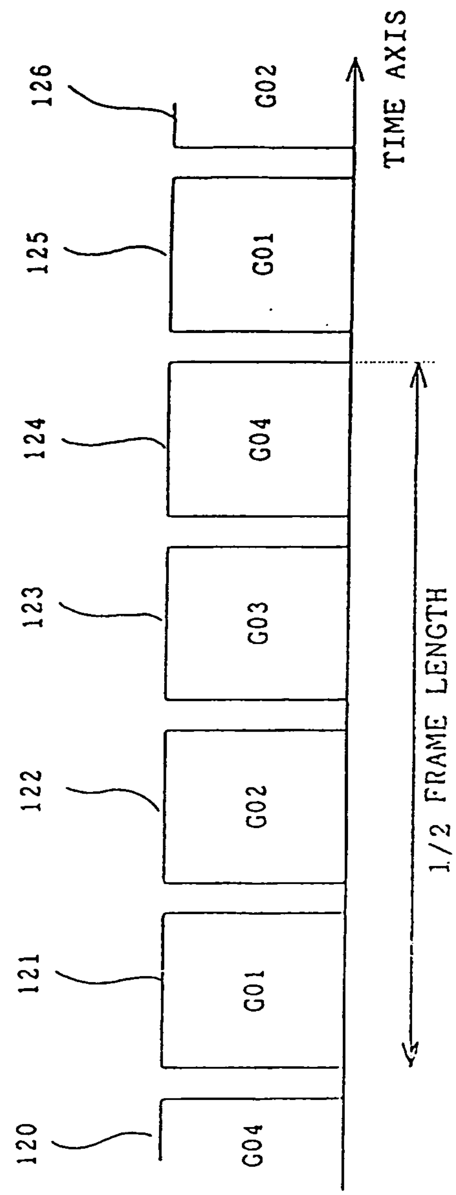

120
121
122
123
124
125
126
G04
G01
G02
G03
G04
G01
G02
TIME AXIS
1/2 FRAME LENGTH

Fig.10

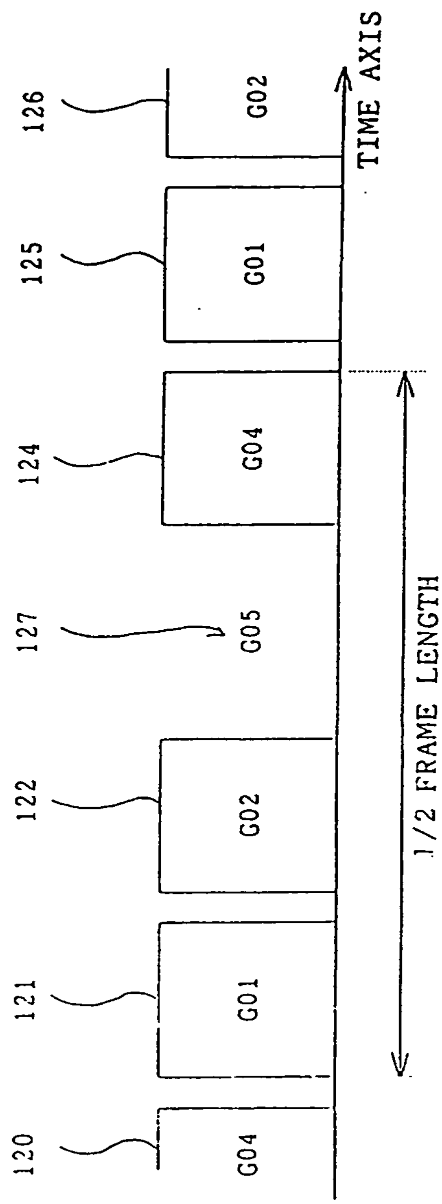

126
125
124
127
122
121
120
G02
G01
G04
G05
G02
G01
G04
TIME AXIS
1/2 FRAME LENGTH

Fig.11

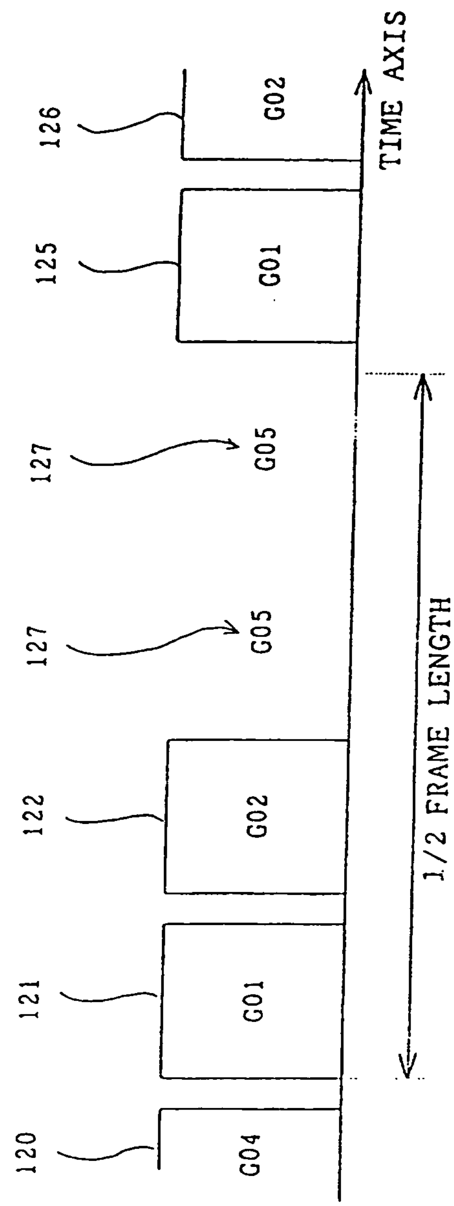

120
121
122
127
127
125
126
G04
G01
G02
G05
G05
G01
G02
TIME AXIS
1/2 FRAME LENGTH

Fig.12

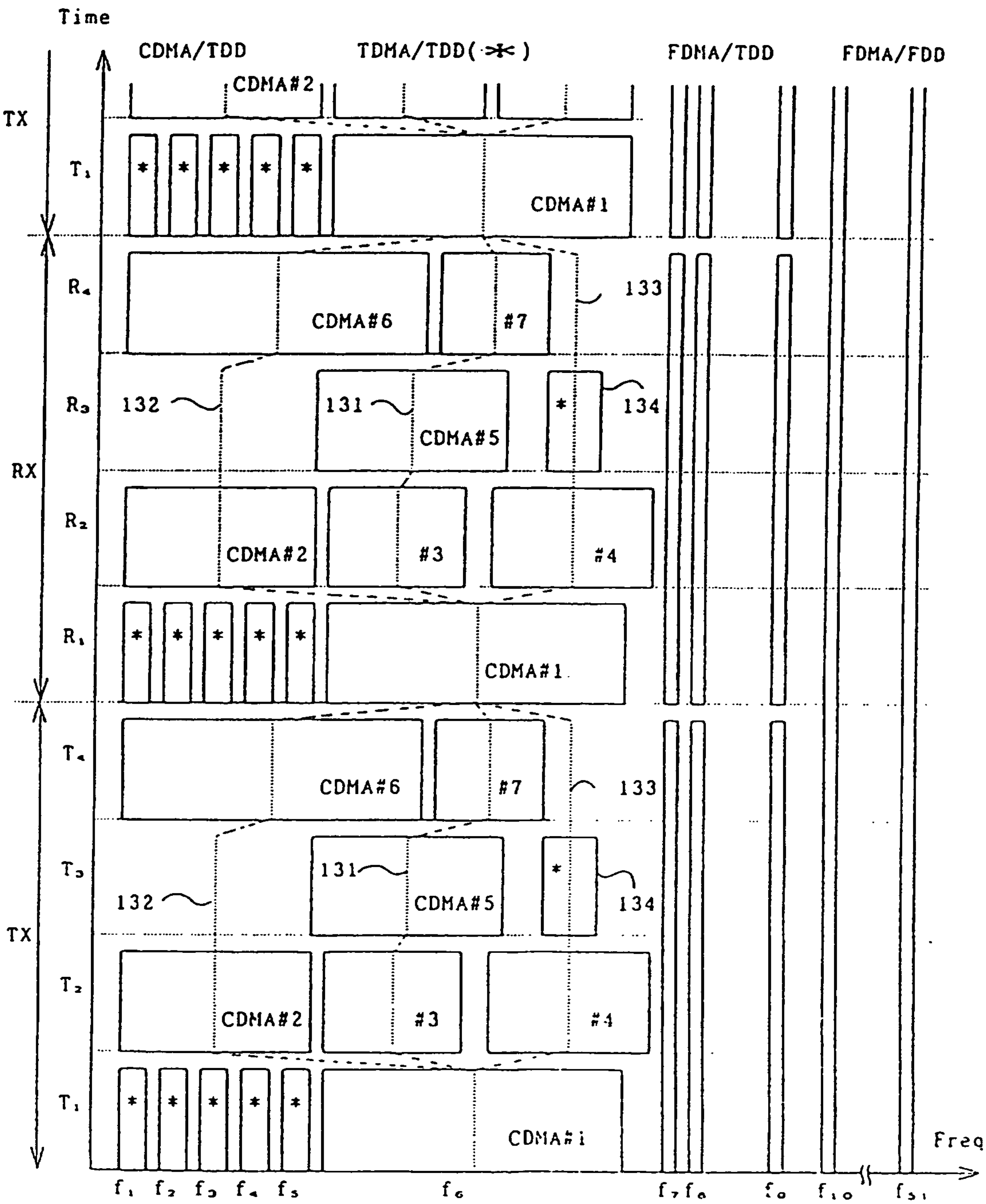
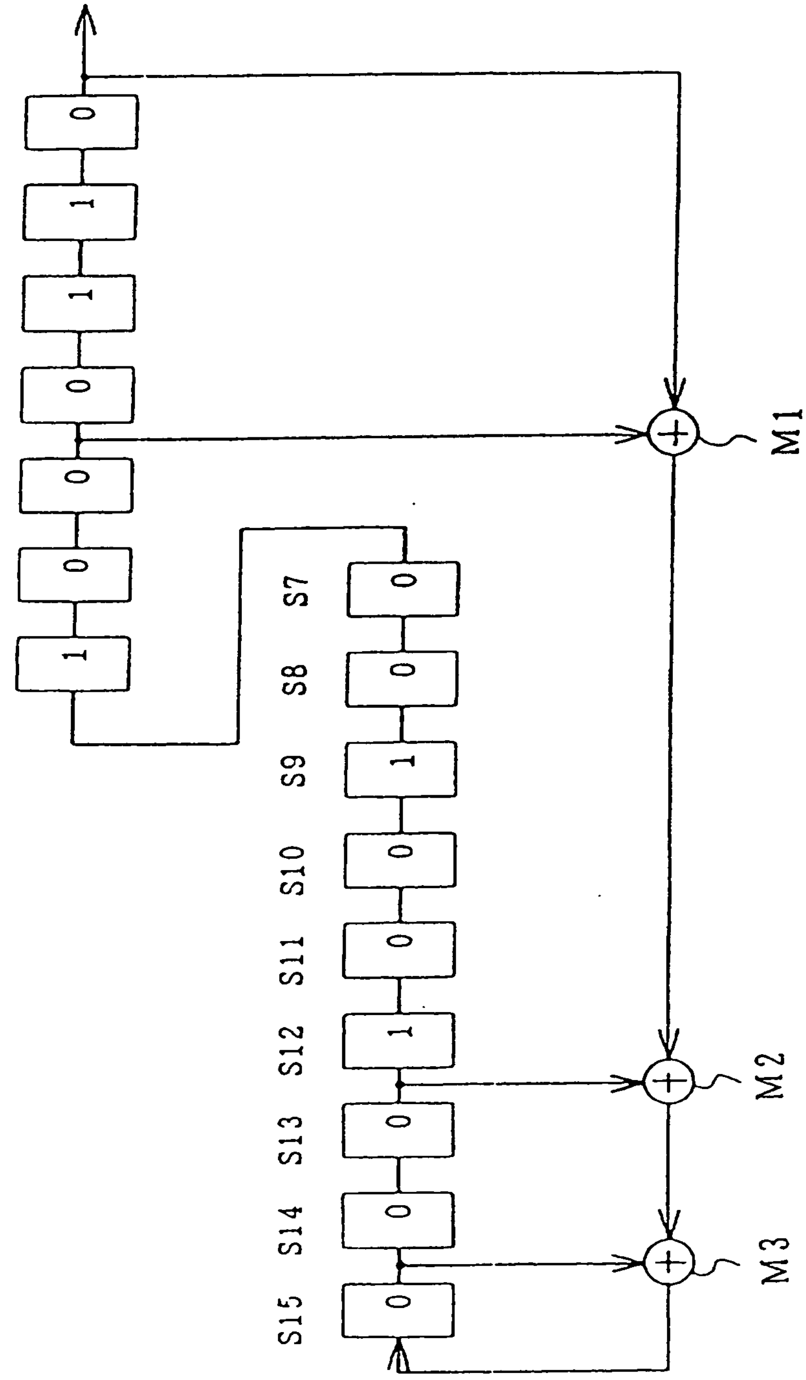

Time
CDMA/TDD
TDMA/TDD(※)
FDMA/TDD
FDMA/FDD
CDMA#2
TX
T₁
CDMA#1
R₄
CDMA#6
#7
133
R₃
132
131
CDMA#5
134
RX
R₂
CDMA#2
#3
#4
R₁
CDMA#1
T₄
CDMA#6
#7
133
T₃
131
132
CDMA#5
134
TX
T₂
CDMA#2
#3
#4
T₁
CDMA#1
Freq.
f₁ f₂ f₃ f₄ f₅
f₆
f₇ f₈
f₉
f₁₀
f₃₁

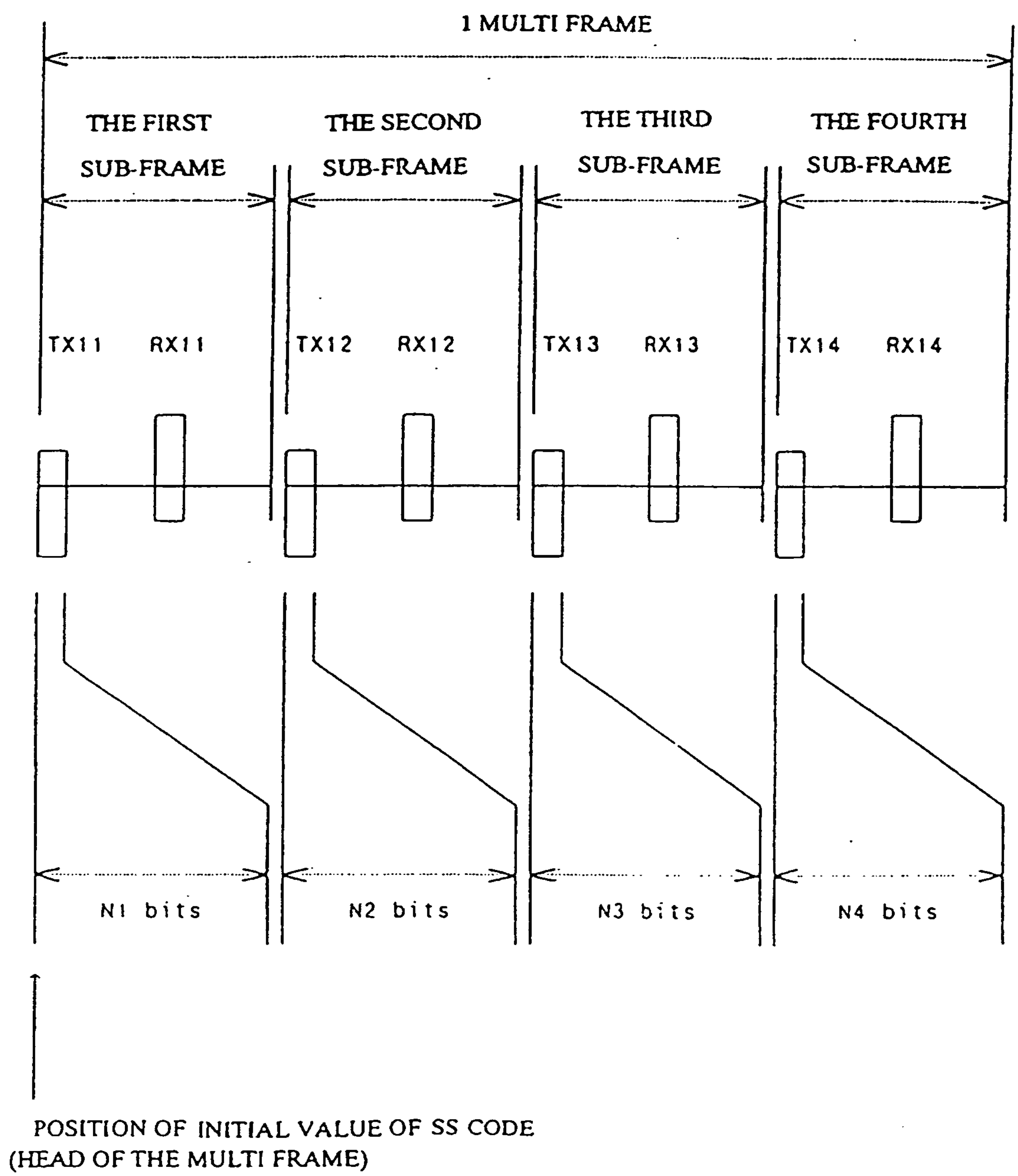
Fig.13



AN EXAMPLE OF INITIAL VALUE OF SS CODE

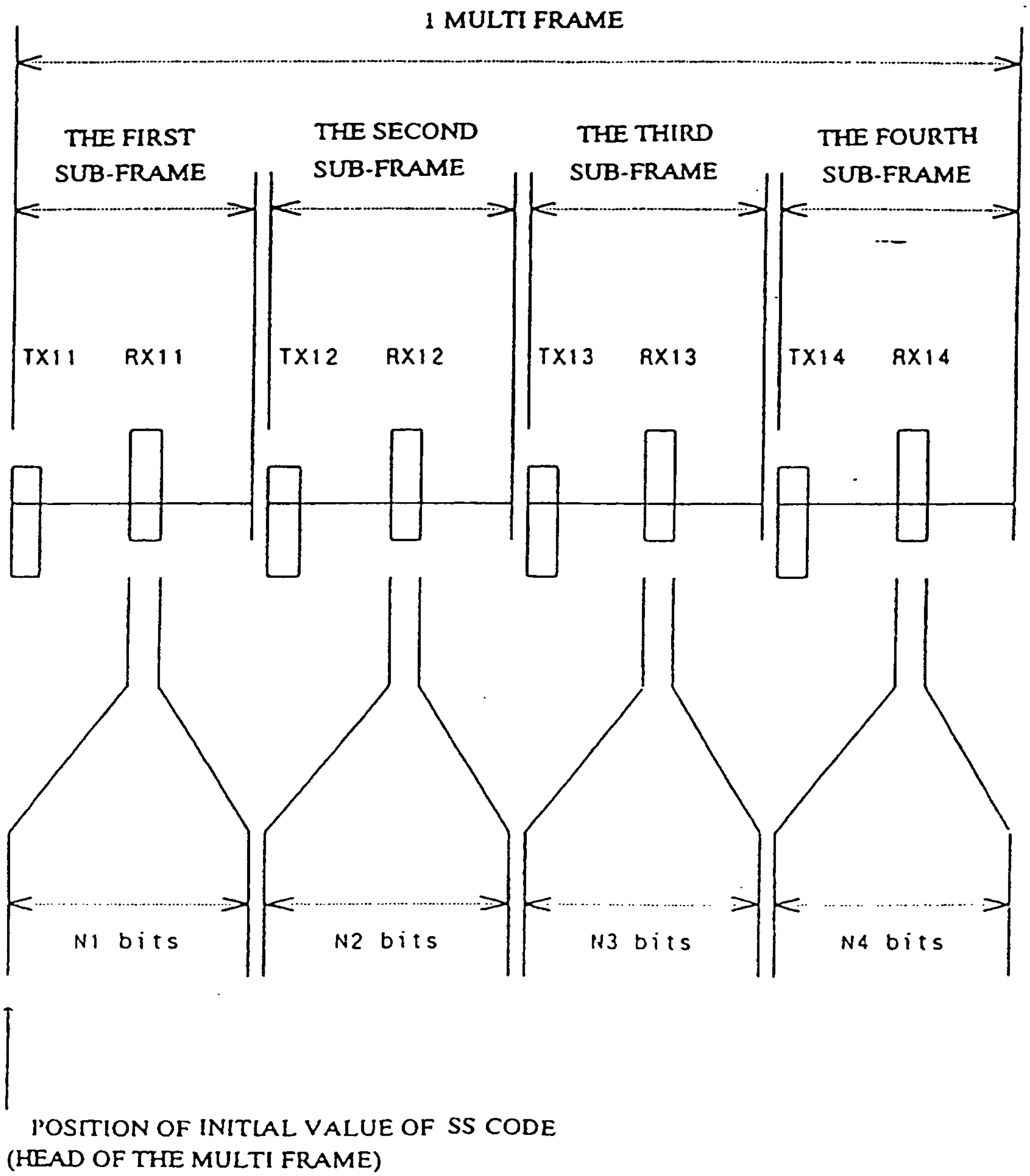
(PN CODE)

Fig. 14



HEAD POSITION OF INITIAL VALUE OF TIME SLOT ON TRANSMITTING SIDE IN A MULTI FRAME (TDD)

Fig.15

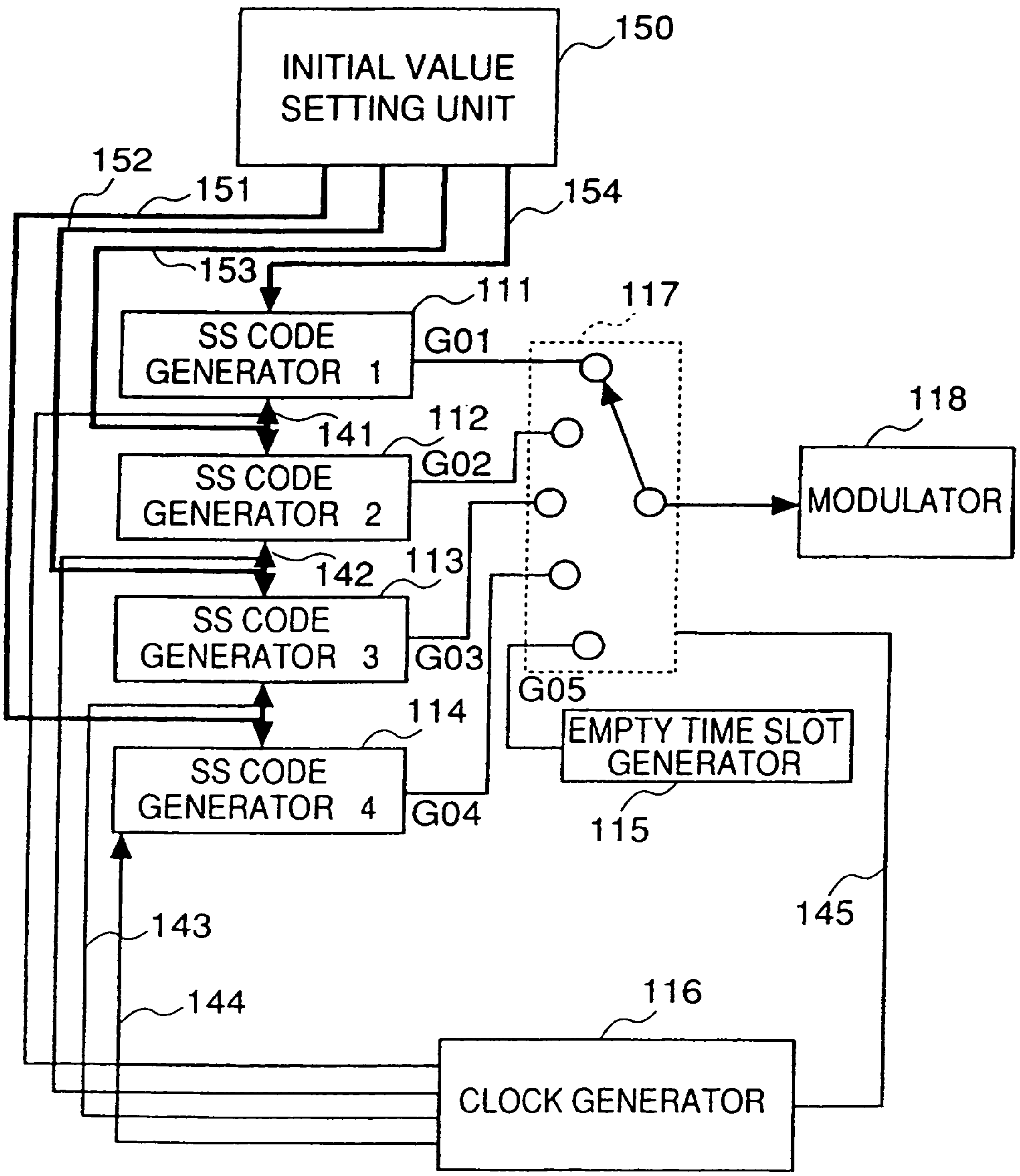


AN EXAMPLE OF TIME SLOT ON RECEIVING SIDE

IN A MULTI FRAME

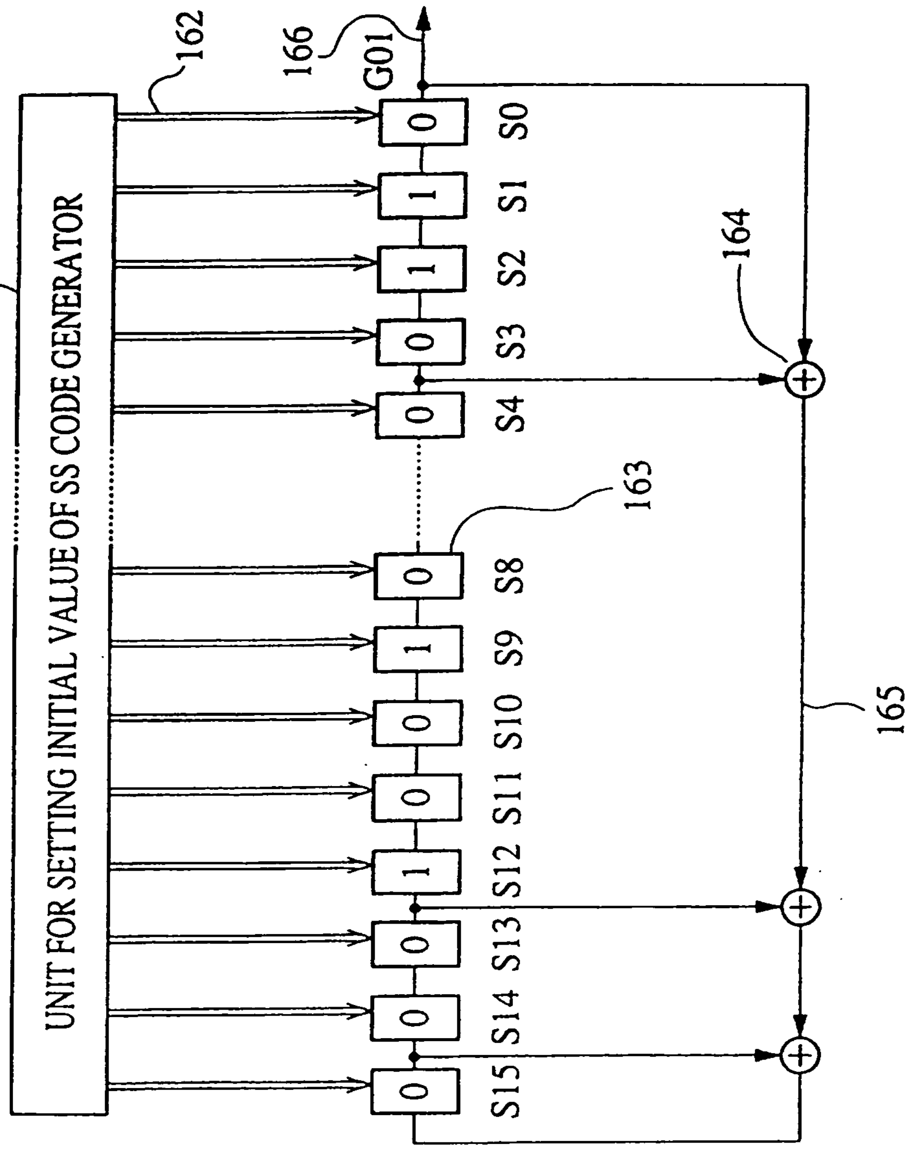
POSITION OF INITIAL VALUE OF SS CODE (TDD)

Fig. 16



RADIO BASE STATION MODEL WITH SS CODE GENERATOR ASSOCIATED WITH TIME SLOT

Fig. 17



AN EXAMPLE OF MECHANISM FOR SETTING INITIAL VALUE OF SS CODE GENERATOR

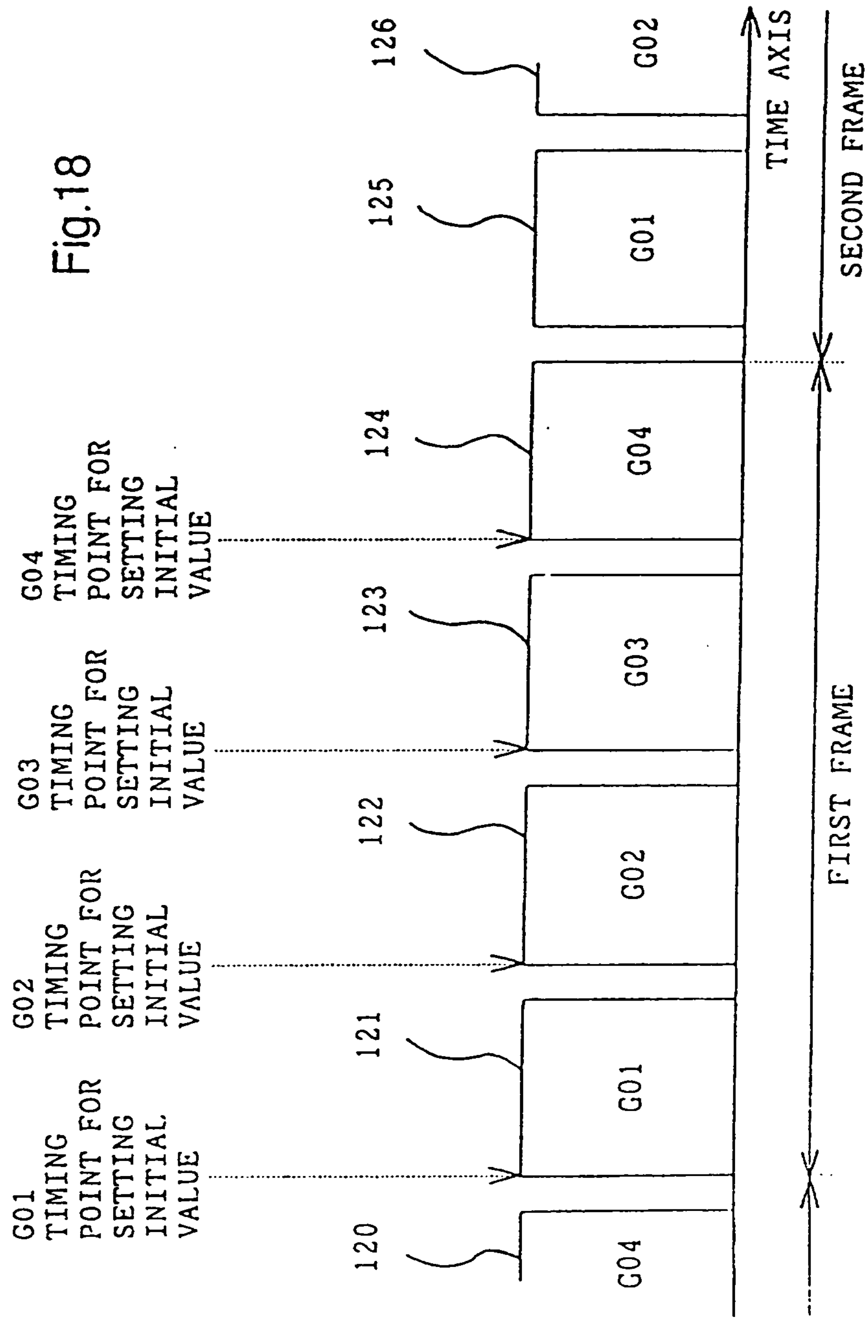

G01 TIMING POINT FOR SETTING INITIAL VALUE
G02 TIMING POINT FOR SETTING INITIAL VALUE
G03 TIMING POINT FOR SETTING INITIAL VALUE
G04 TIMING POINT FOR SETTING INITIAL VALUE
120
121
122
123
124
125
126
G04
G01
G02
G03
G04
G01
G02
TIME AXIS
FIRST FRAME
SECOND FRAME

Fig.18

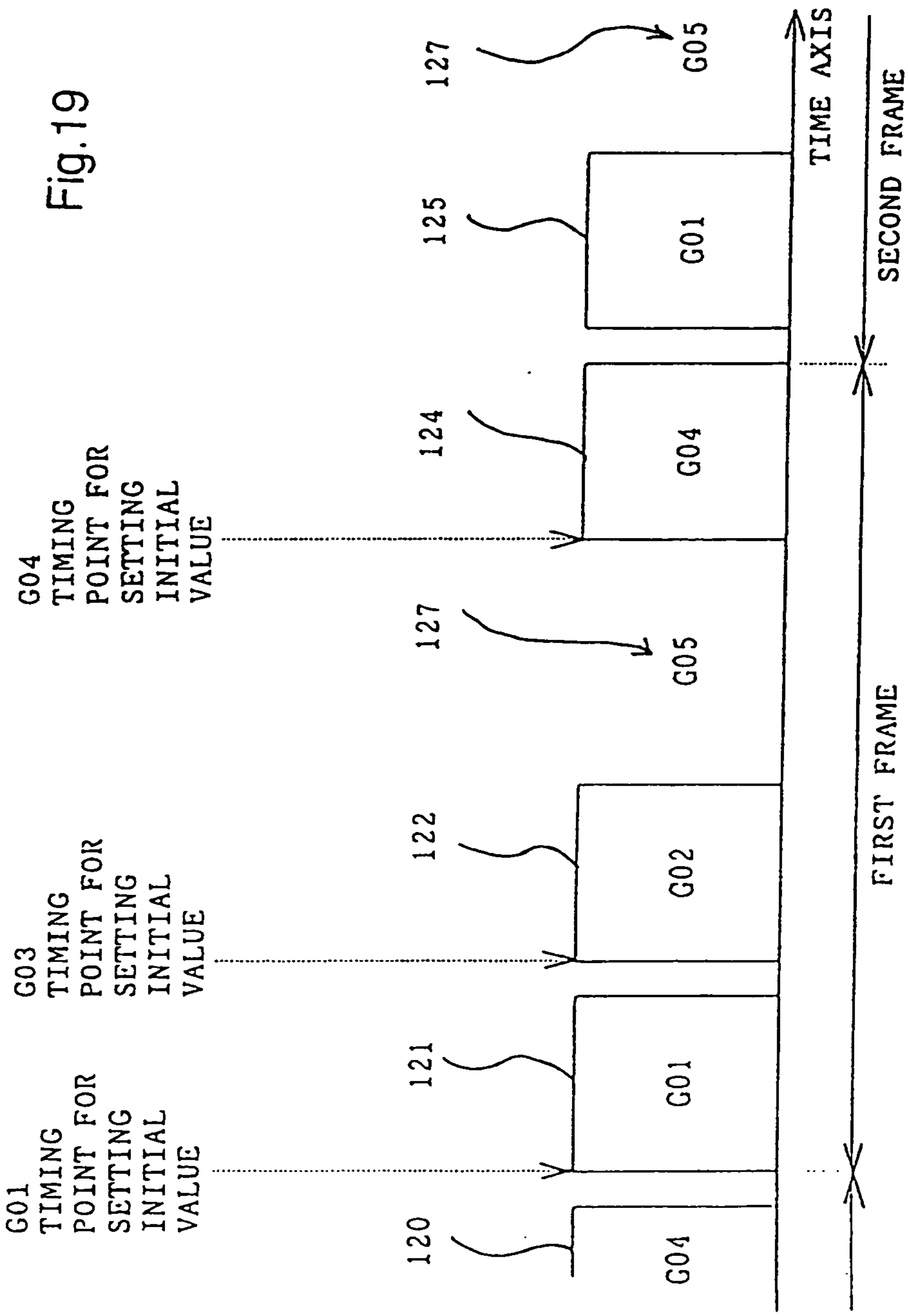
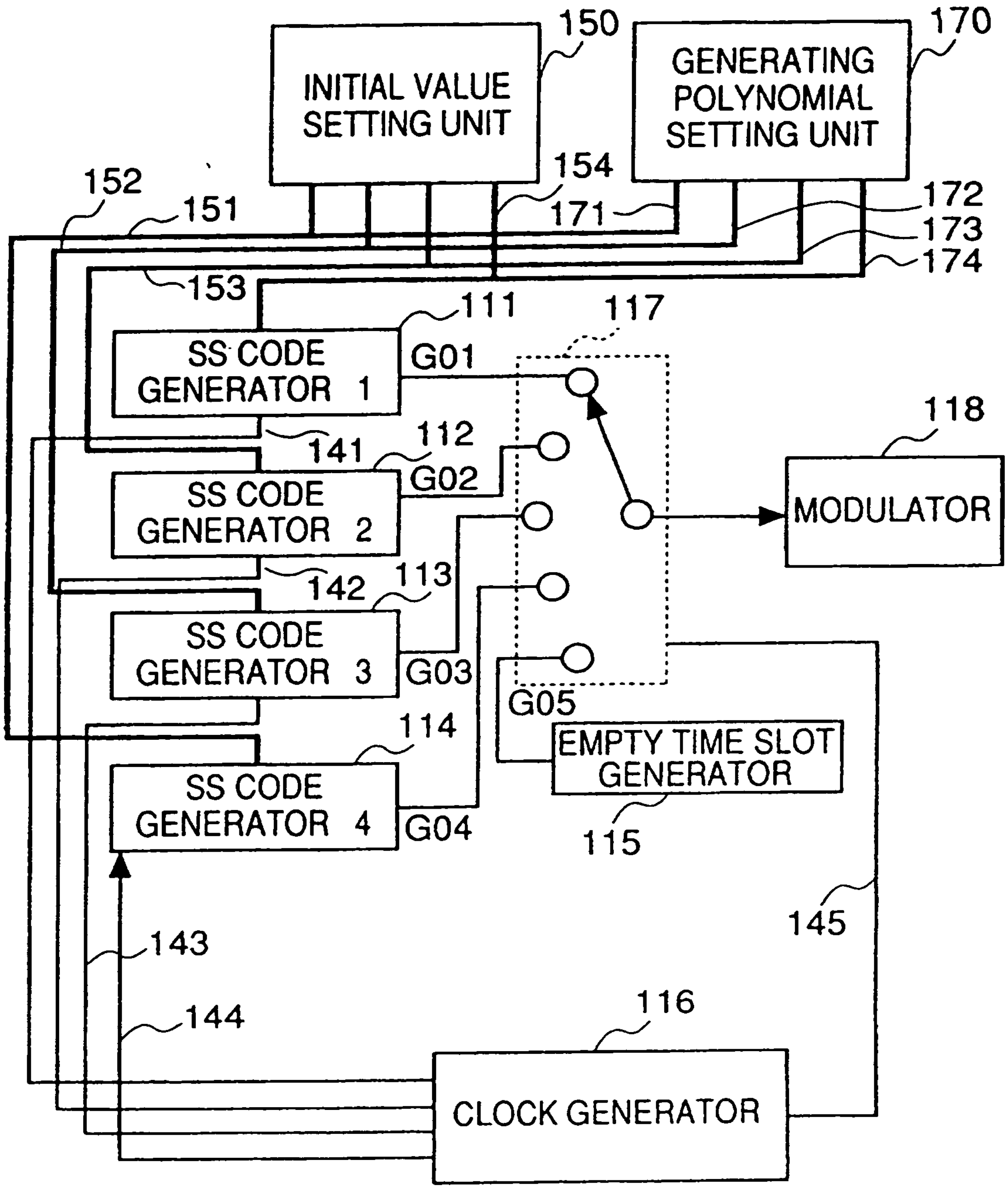

G01 TIMING POINT FOR SETTING INITIAL VALUE
G03 TIMING POINT FOR SETTING INITIAL VALUE
G04 TIMING POINT FOR SETTING INITIAL VALUE
120
121
122
127
124
125
127
G04
G01
G02
G05
G04
G01
G05
TIME AXIS
FIRST FRAME
SECOND FRAME

Fig.19

Fig. 20



RADIO BASE STATION MODEL WITH MECHANISM FOR SETTING GENERATING POLYNOMIAL OF SS CODE GENERATOR

Fig. 21

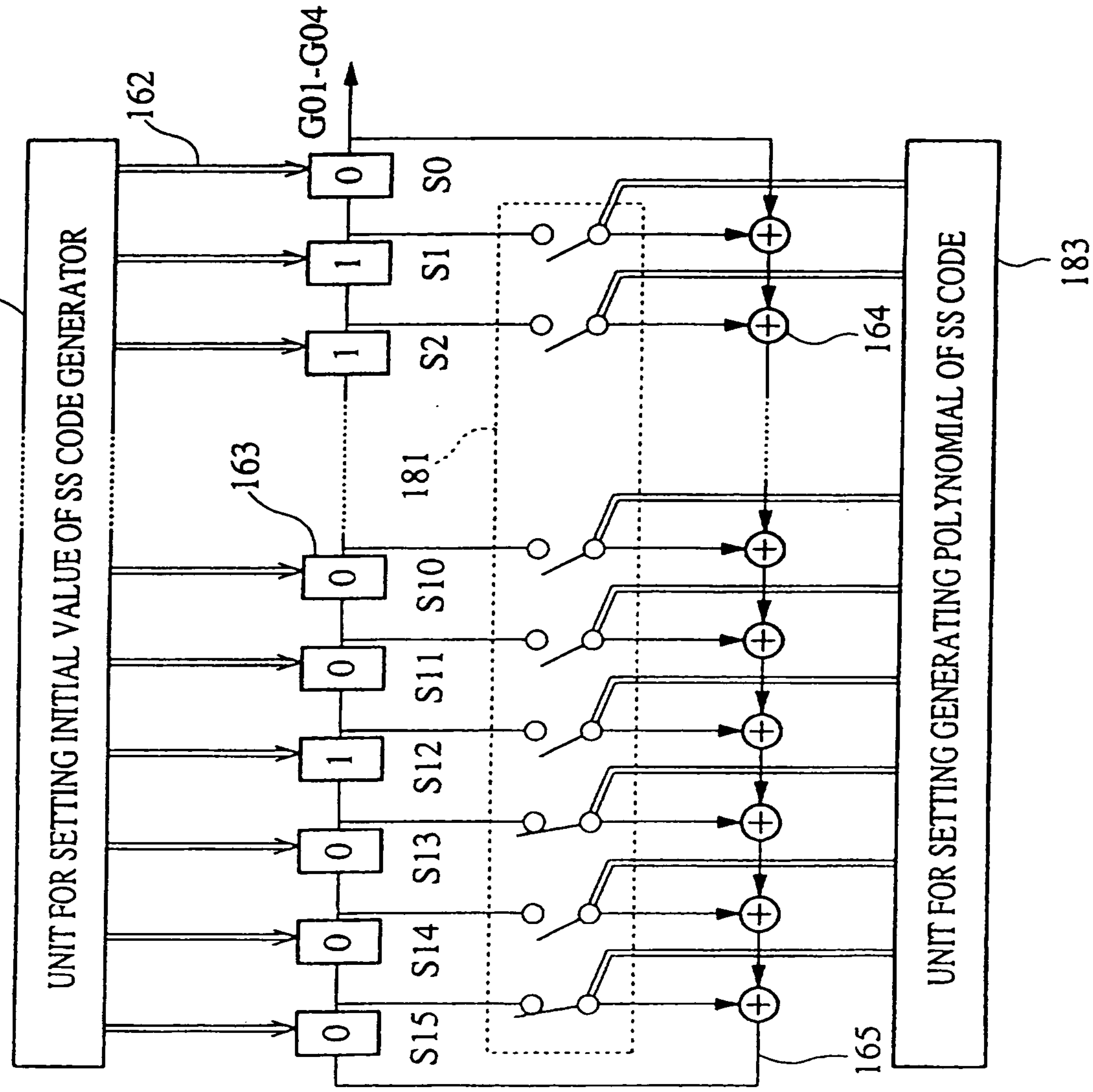

UNIT FOR SETTING INITIAL VALUE OF SS CODE GENERATOR
UNIT FOR SETTING GENERATING POLYNOMIAL OF SS CODE
G01-G04
161
162
163
164
165
181
183
S0
S1
S2
S10
S11
S12
S13
S14
S15
0
1
1
0
0
1
0
0
0

Fig.22

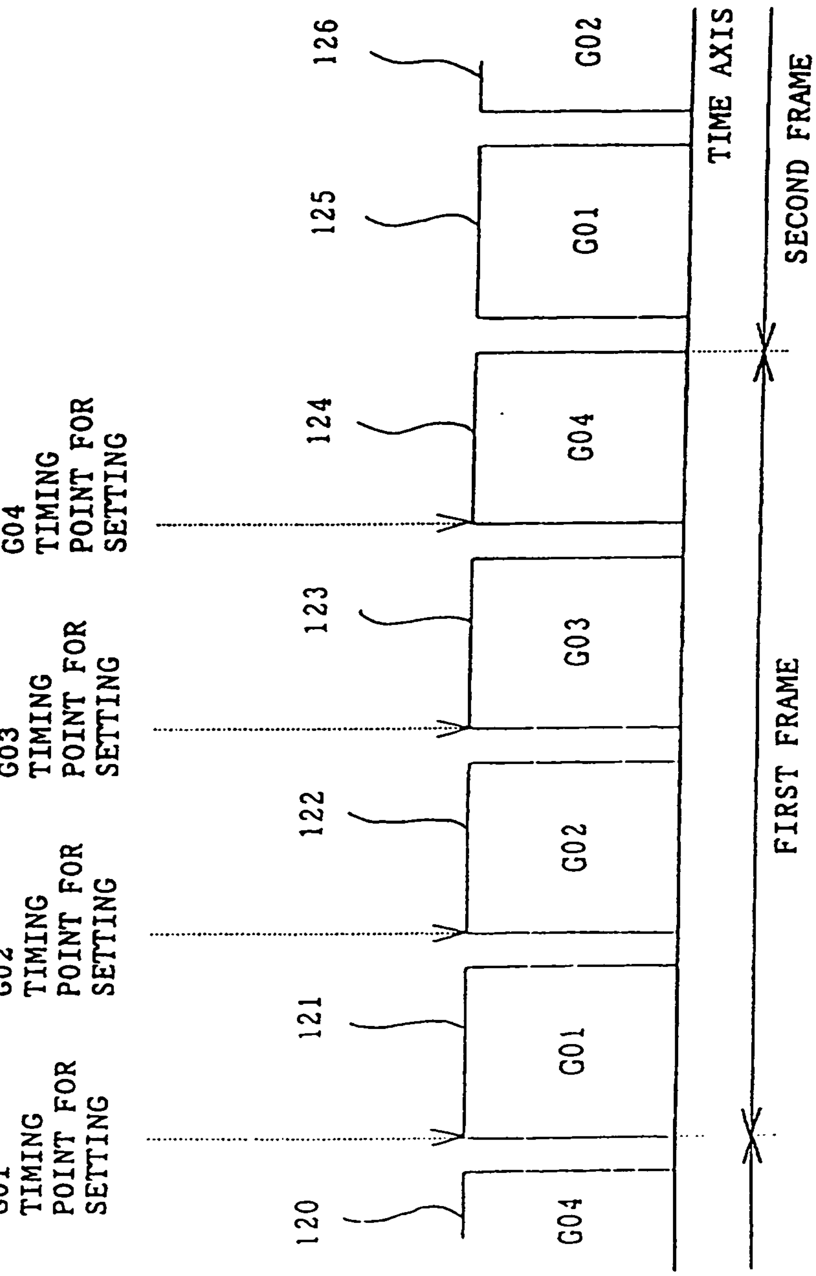

G01 TIMING POINT FOR SETTING
G02 TIMING POINT FOR SETTING
G03 TIMING POINT FOR SETTING
G04 TIMING POINT FOR SETTING
120
121
122
123
124
125
126
G04
G01
G02
G03
G04
G01
G02
TIME AXIS
FIRST FRAME
SECOND FRAME

Fig. 23

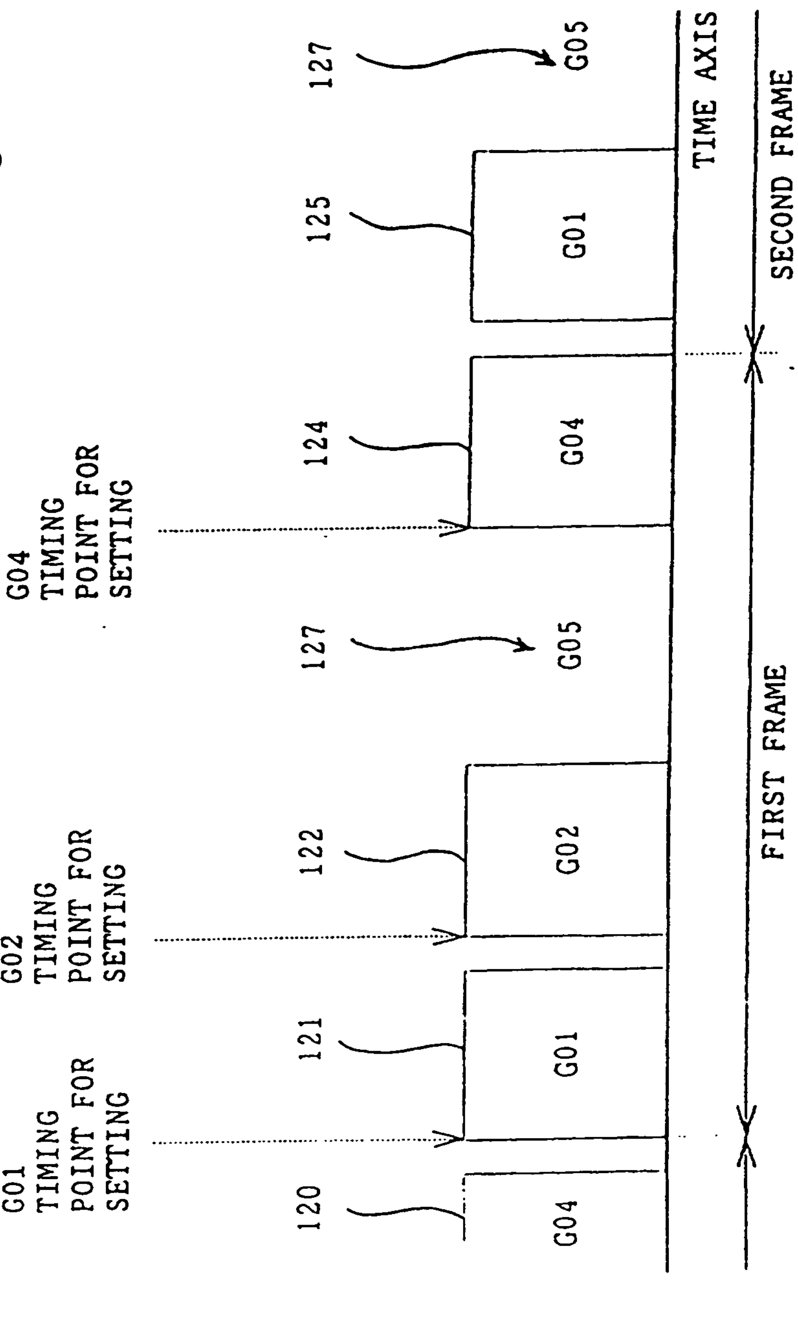
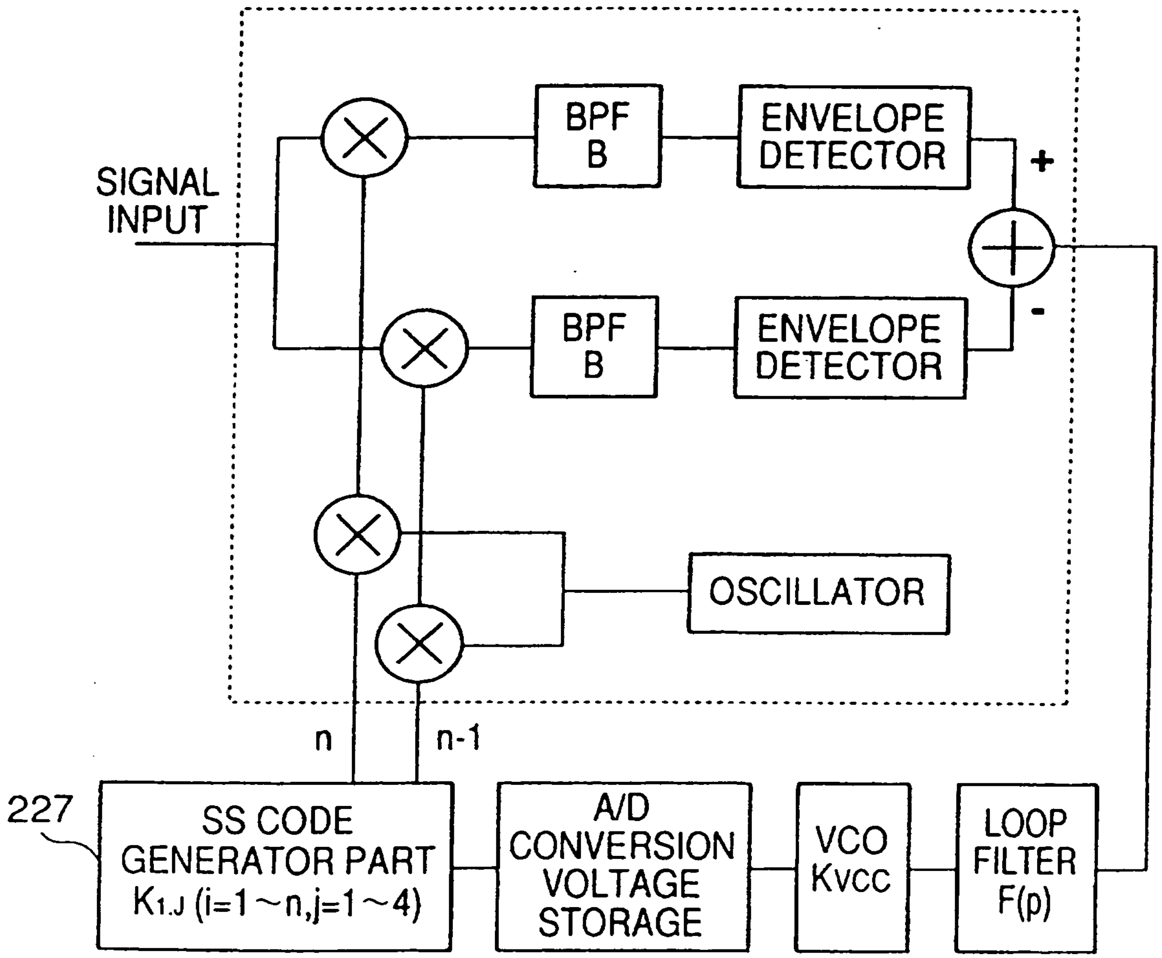

G01 TIMING POINT FOR SETTING
G02 TIMING POINT FOR SETTING
G04 TIMING POINT FOR SETTING
120
121
122
127
124
125
127
G04
G01
G02
G05
G04
G01
G05
TIME AXIS
FIRST FRAME
SECOND FRAME

Fig. 24

ENVELOPE CORRELATION NETWORK



NONCOHERENT DELAY LOCK LOOP WITH MULTI SS CODE GENERATOR

Fig. 25

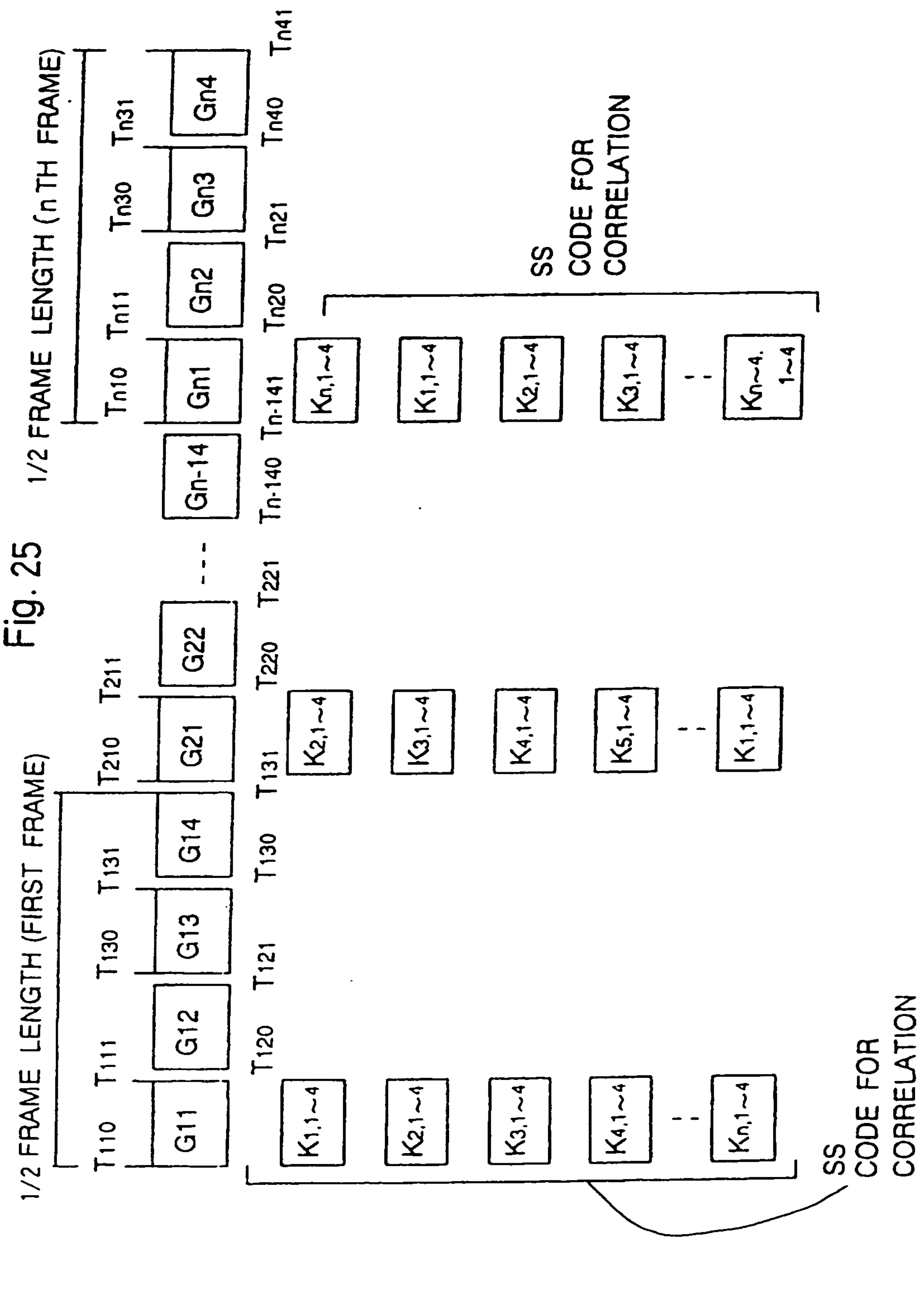

1/2 FRAME LENGTH (FIRST FRAME)
1/2 FRAME LENGTH (n TH FRAME)
G11
G12
G13
G14
G21
G22
Gn-14
Gn1
Gn2
Gn3
Gn4
T110
T111
T120
T121
T130
T131
T210
T211
T220
T221
Tn-140
Tn-141
Tn10
Tn11
Tn20
Tn21
Tn30
Tn31
Tn40
Tn41
K1,1~4
K2,1~4
K3,1~4
K4,1~4
Kn,1~4
K5,1~4
Kn~4, 1~4
SS
CODE FOR
CORRELATION

Fig. 26

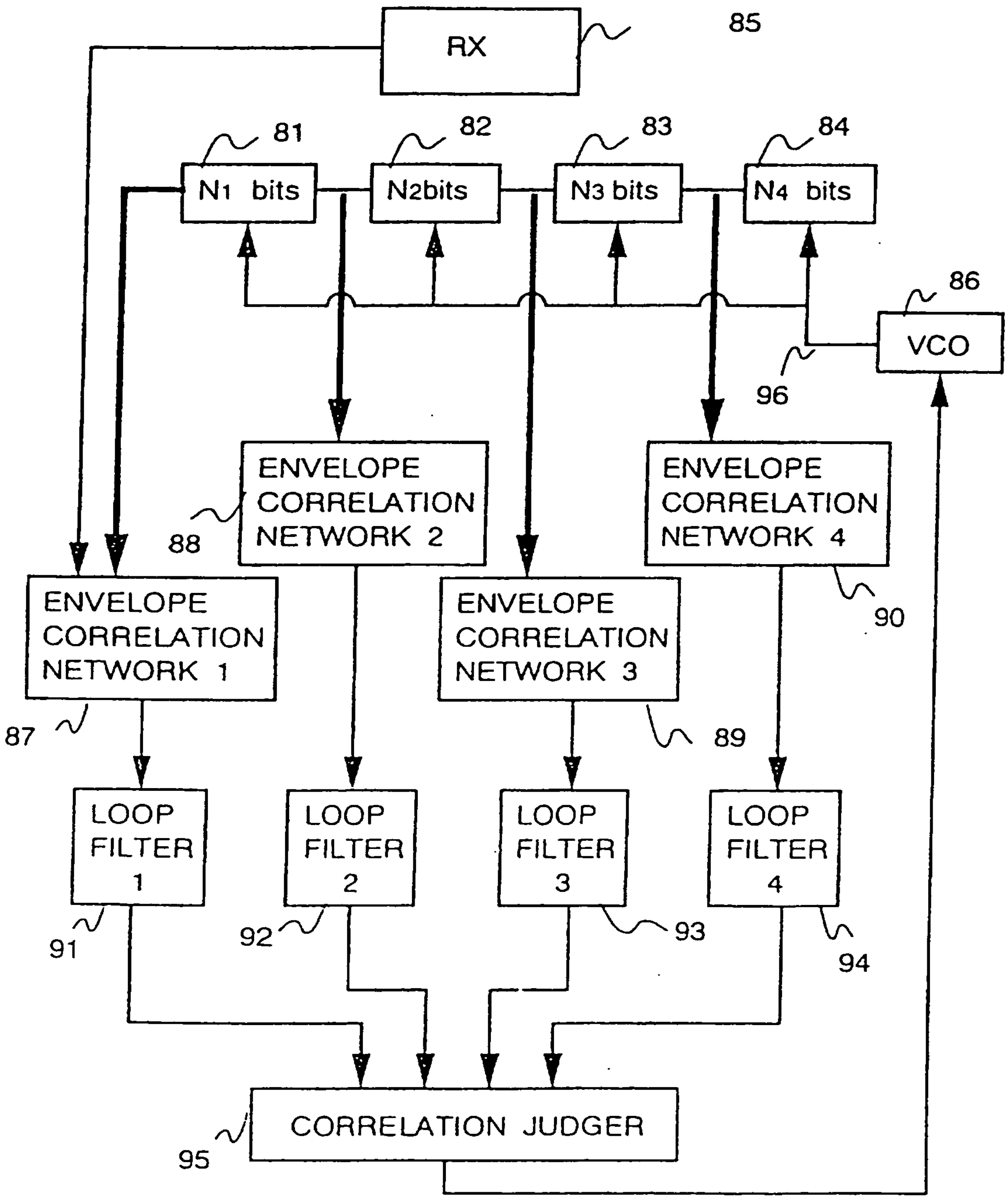
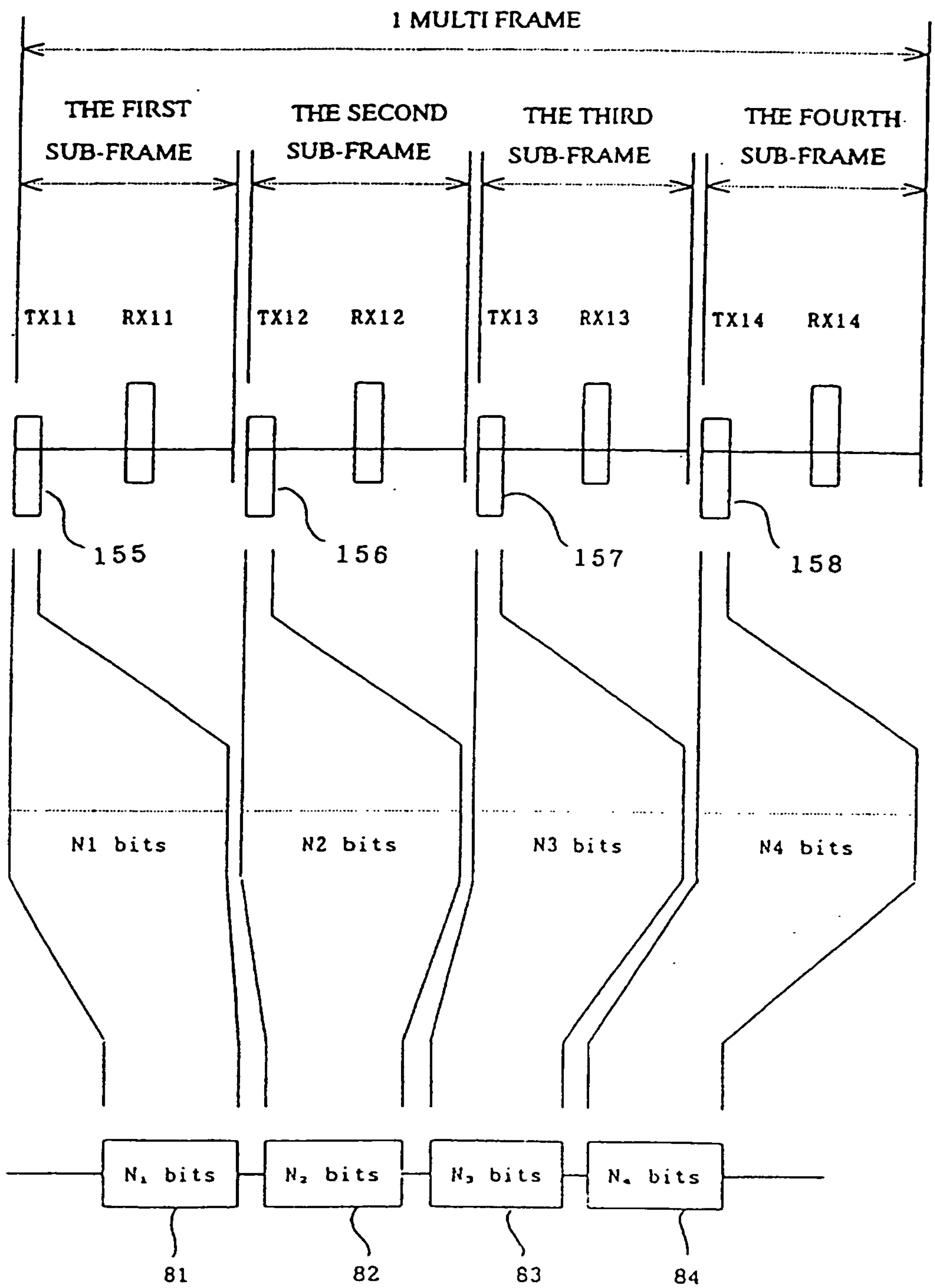

RX
85
81
82
83
84
N1 bits
N2bits
N3 bits
N4 bits
86
VCO
96
ENVELOPE CORRELATION NETWORK 2
88
ENVELOPE CORRELATION NETWORK 4
90
ENVELOPE CORRELATION NETWORK 1
ENVELOPE CORRELATION NETWORK 3
87
89
LOOP FILTER 1
LOOP FILTER 2
LOOP FILTER 3
LOOP FILTER 4
91
92
93
94
CORRELATION JUDGER
95

Fig.27



RELATIONSHIP BETWEEN TIME SLOT IN A MULTI FRAME AND A RECEIVING CORRELATION CODE SHIFT REGISTOR

Fig. 28

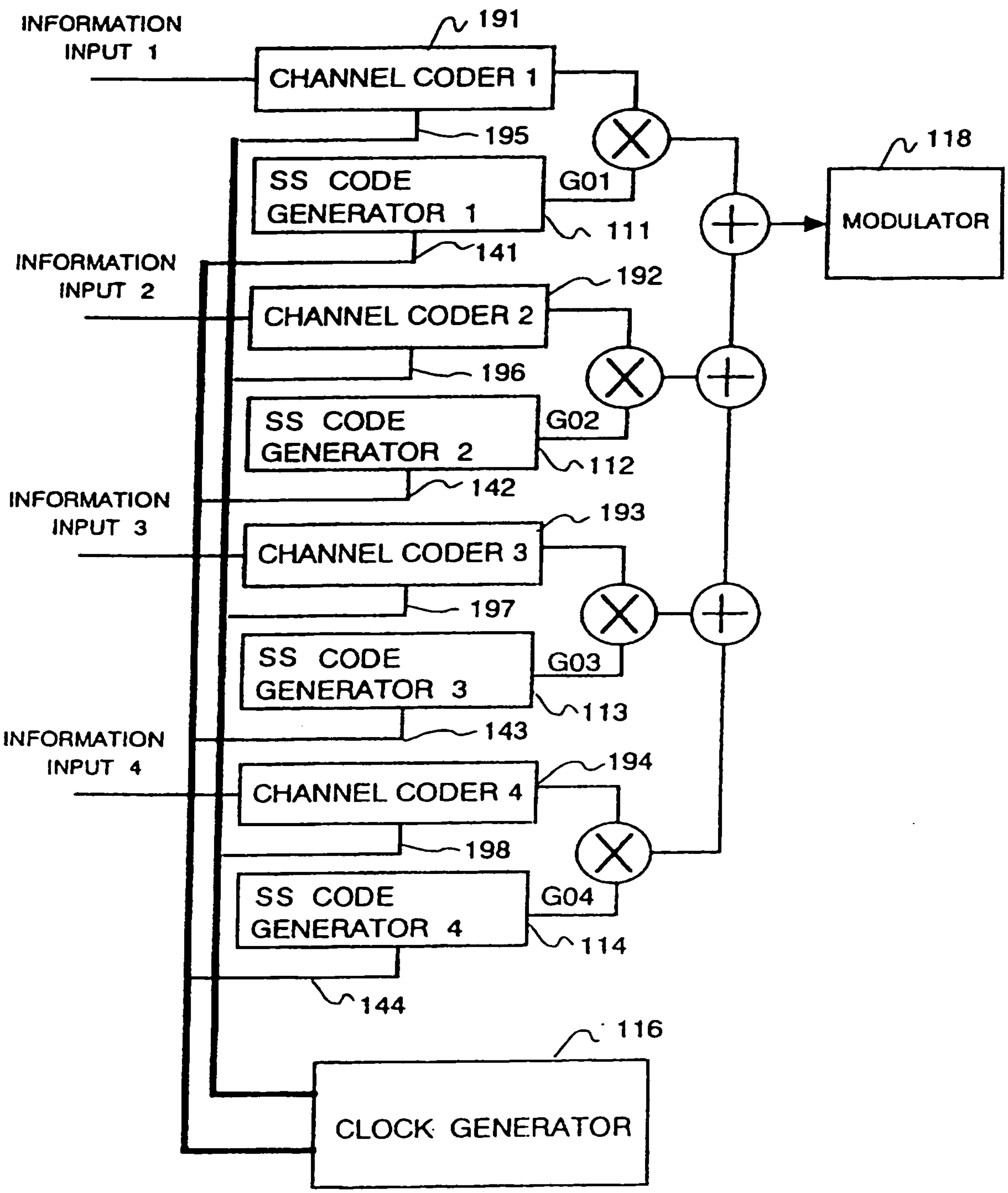

INFORMATION INPUT 1
191
CHANNEL CODER 1
195
SS CODE GENERATOR 1
G01
111
141
118
MODULATOR
INFORMATION INPUT 2
192
CHANNEL CODER 2
196
SS CODE GENERATOR 2
G02
112
142
INFORMATION INPUT 3
193
CHANNEL CODER 3
197
SS CODE GENERATOR 3
G03
113
143
INFORMATION INPUT 4
194
CHANNEL CODER 4
198
SS CODE GENERATOR 4
G04
114
144
116
CLOCK GENERATOR

Fig. 29

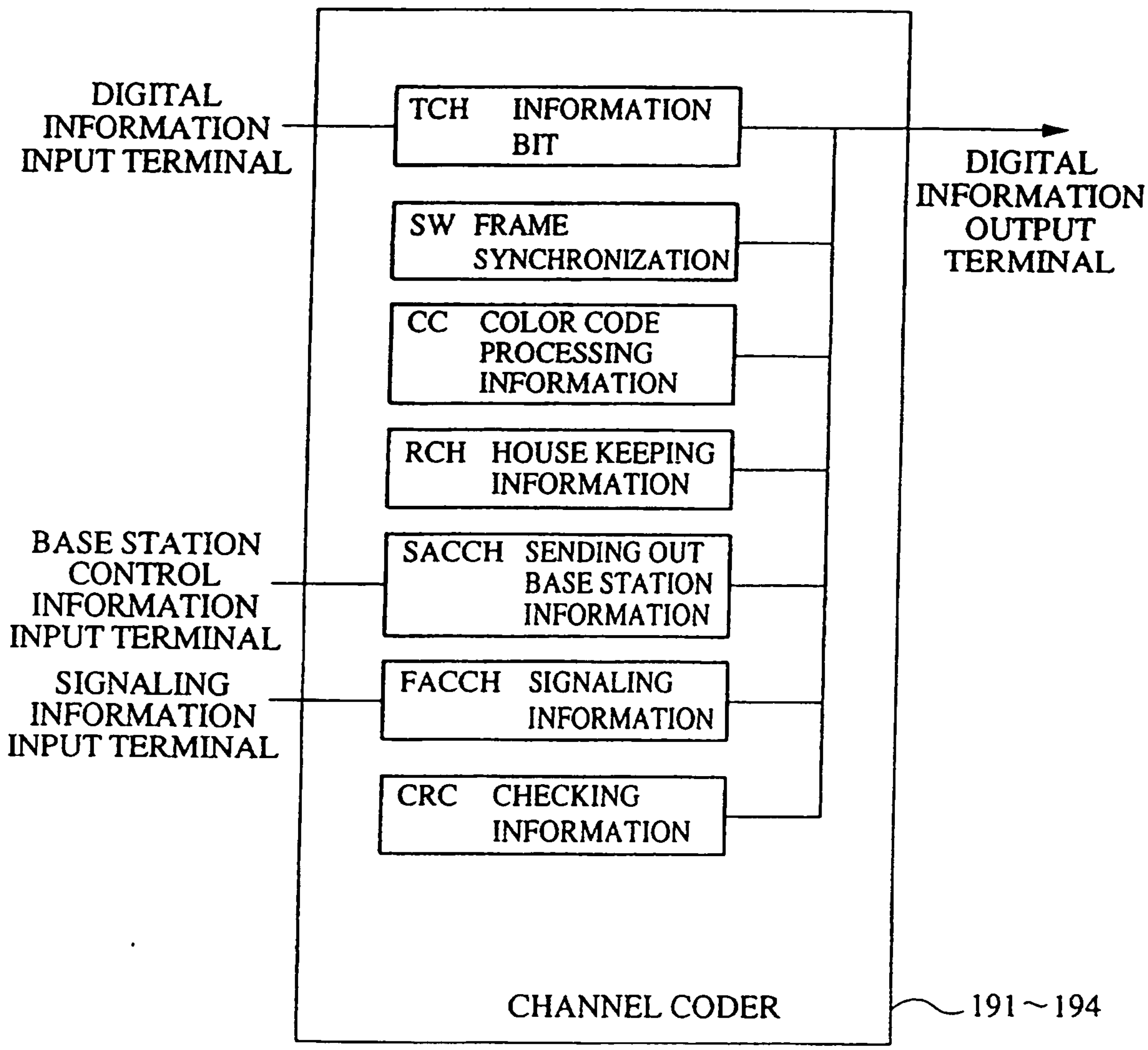

DIGITAL INFORMATION INPUT TERMINAL
TCH INFORMATION BIT
SW FRAME SYNCHRONIZATION
CC COLOR CODE PROCESSING INFORMATION
RCH HOUSE KEEPING INFORMATION
BASE STATION CONTROL INFORMATION INPUT TERMINAL
SACCH SENDING OUT BASE STATION INFORMATION
SIGNALING INFORMATION INPUT TERMINAL
FACCH SIGNALING INFORMATION
CRC CHECKING INFORMATION
DIGITAL INFORMATION OUTPUT TERMINAL
CHANNEL CODER
191~194

Fig.30

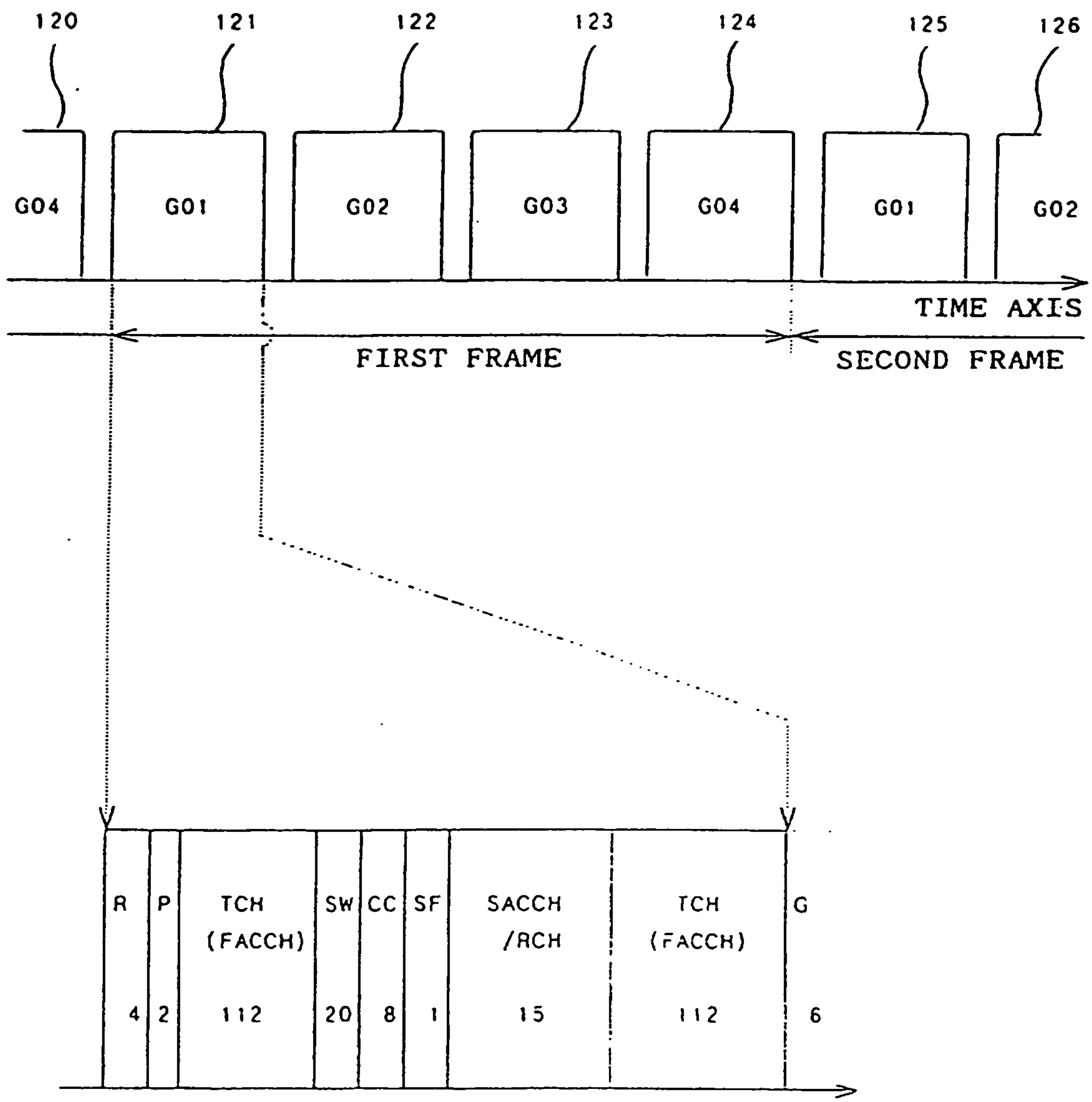

120
121
122
123
124
125
126
G04
G01
G02
G03
G04
G01
G02
TIME AXIS
FIRST FRAME
SECOND FRAME
R
4
P
2
TCH
(FACCH)
112
SW
20
CC
8
SF
1
SACCH
/RCH
15
TCH
(FACCH)
112
G
6

Fig. 31

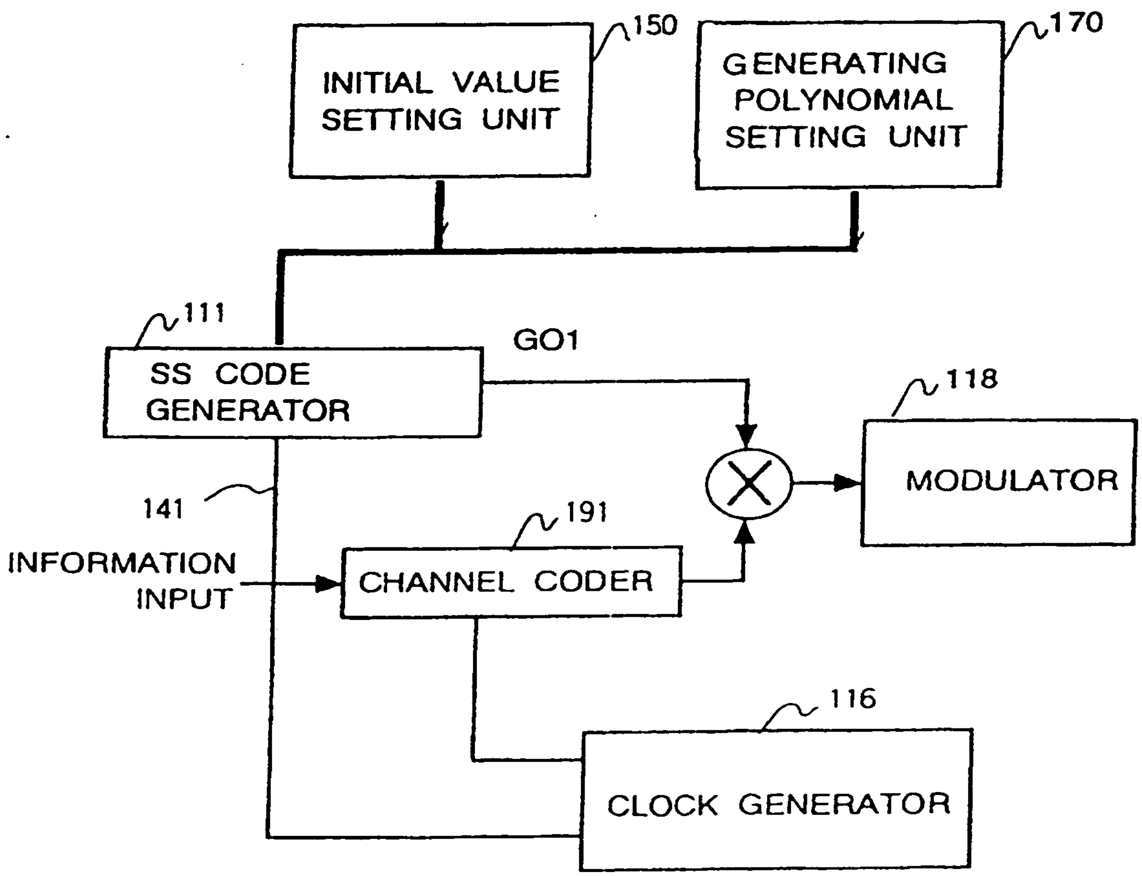

150
INITIAL VALUE SETTING UNIT
170
GENERATING POLYNOMIAL SETTING UNIT
111
SS CODE GENERATOR
GO1
118
MODULATOR
141
191
INFORMATION INPUT
CHANNEL CODER
116
CLOCK GENERATOR

Fig. 32

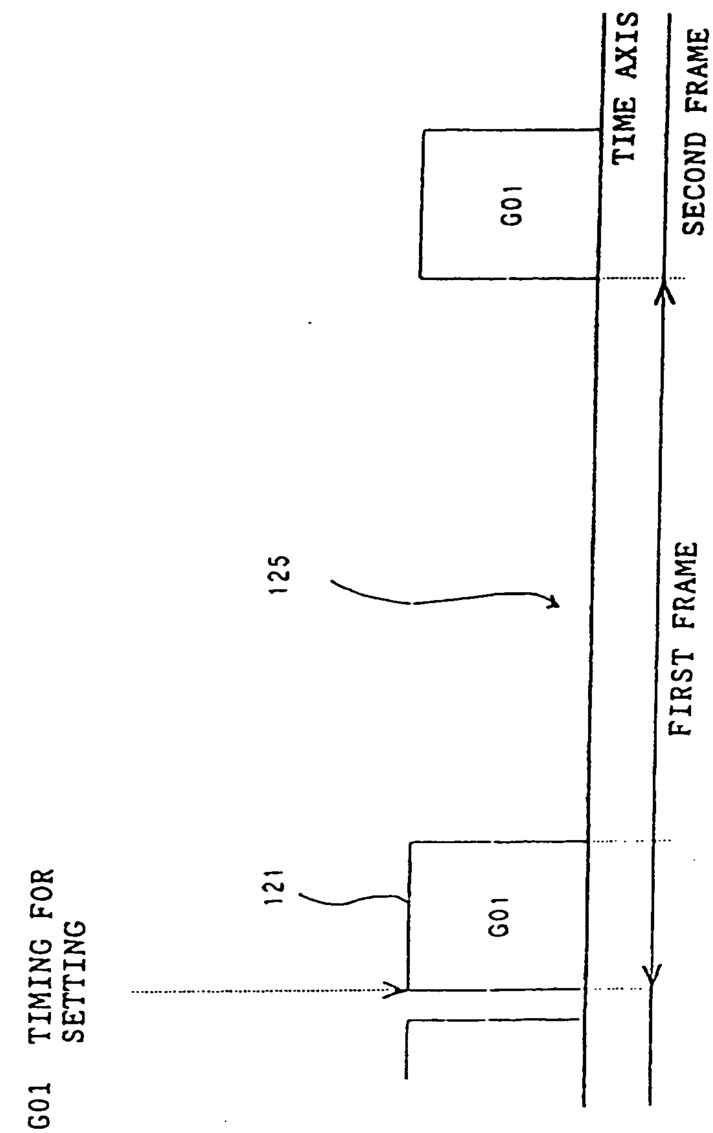

G01 TIMING FOR SETTING
121
G01
125
G01
TIME AXIS
FIRST FRAME
SECOND FRAME

Fig. 33

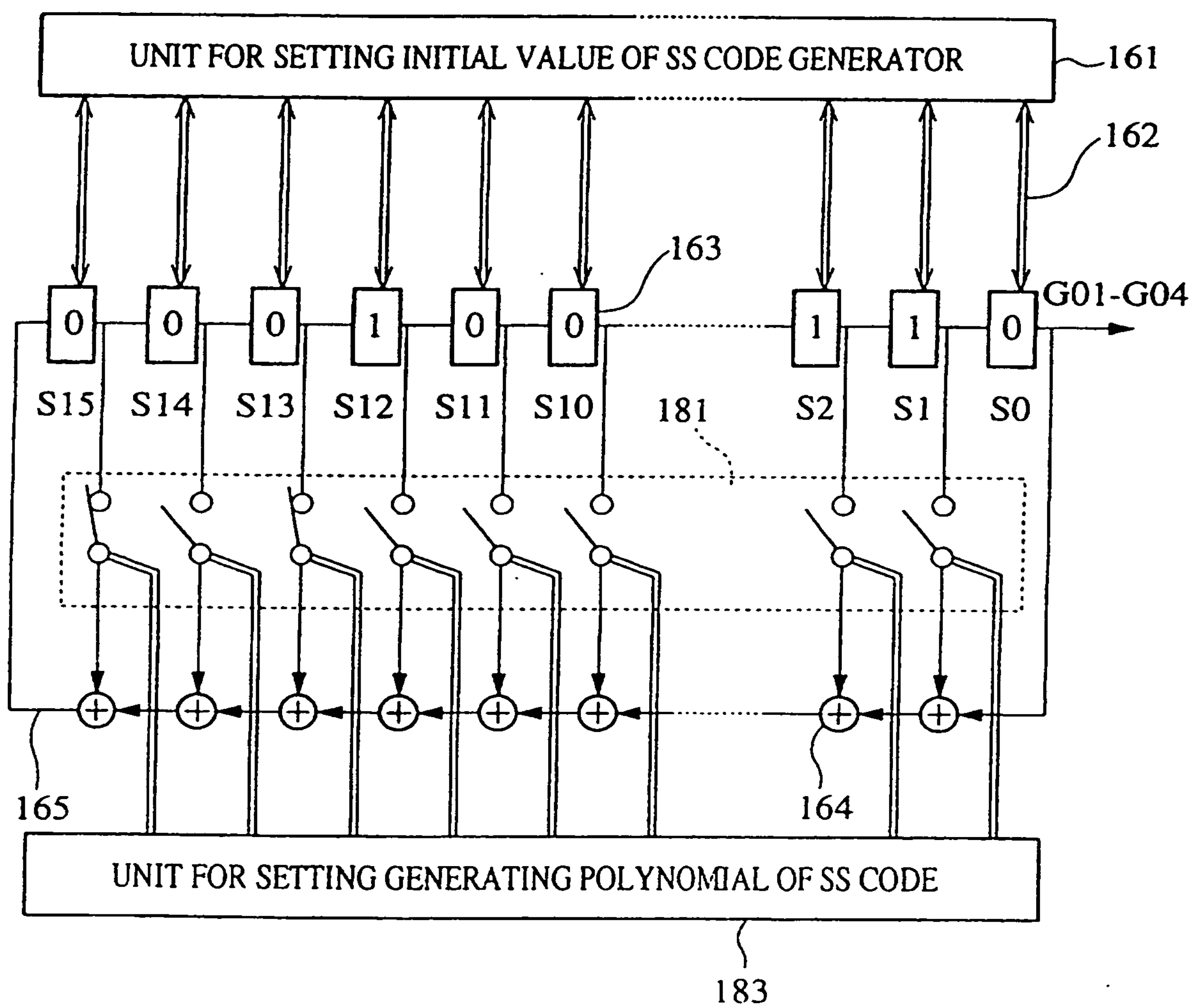

UNIT FOR SETTING INITIAL VALUE OF SS CODE GENERATOR
161
162
163
G01-G04
0
0
0
1
0
0
1
1
0
S15
S14
S13
S12
S11
S10
181
S2
S1
S0
165
164
UNIT FOR SETTING GENERATING POLYNOMIAL OF SS CODE
183

Fig. 34

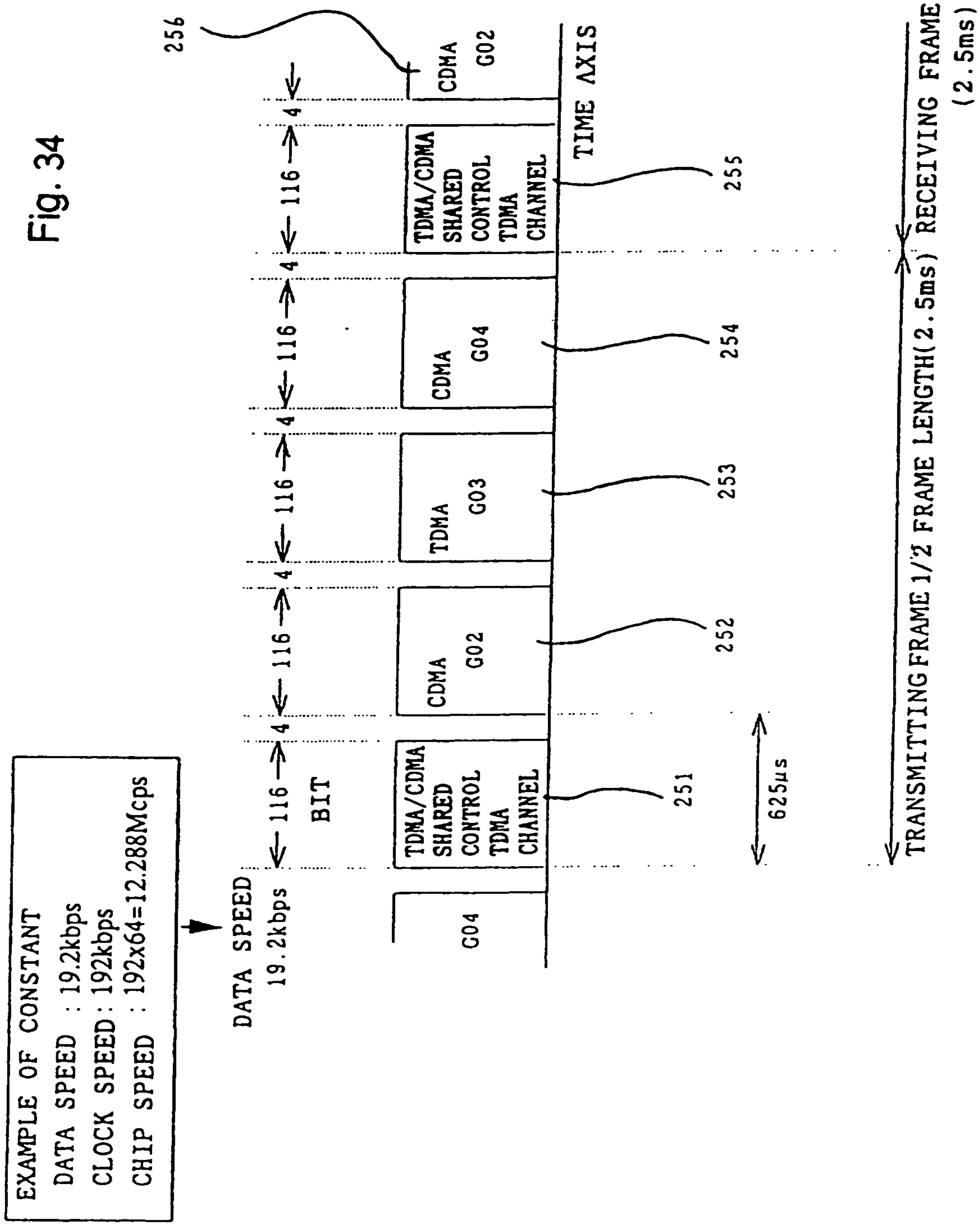

EXAMPLE OF CONSTANT
DATA SPEED : 19.2kbps
CLOCK SPEED : 192kbps
CHIP SPEED : 192x64=12.288Mcps
DATA SPEED
19.2kbps
116
BIT
4
TDMA/CDMA SHARED CONTROL TDMA CHANNEL
CDMA G02
TDMA G03
CDMA G04
G04
251
252
253
254
255
256
625μs
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH(2.5ms)
RECEIVING FRAME (2.5ms)

Fig. 35

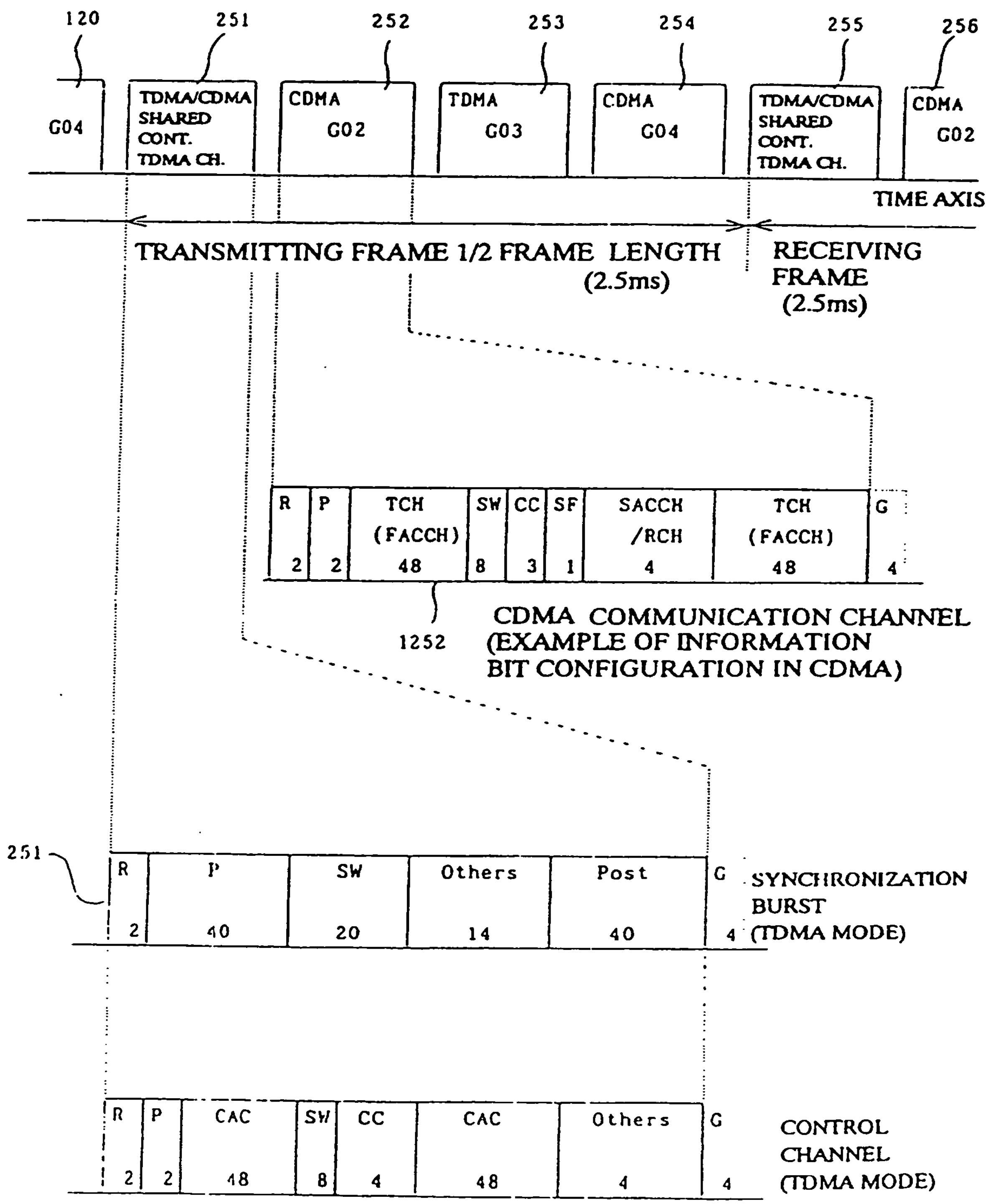

120
251
252
253
254
255
256
G04
TDMA/CDMA SHARED CONT. TDMA CH.
CDMA G02
TDMA G03
CDMA G04
TDMA/CDMA SHARED CONT. TDMA CH.
CDMA G02
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME (2.5ms)
R 2
P 2
TCH (FACCH) 48
SW 8
CC 3
SF 1
SACCH /RCH 4
TCH (FACCH) 48
G 4
1252
CDMA COMMUNICATION CHANNEL (EXAMPLE OF INFORMATION BIT CONFIGURATION IN CDMA)
251
R 2
P 40
SW 20
Others 14
Post 40
G 4
SYNCHRONIZATION BURST (TDMA MODE)
R 2
P 2
CAC 48
SW 8
CC 4
CAC 48
Others 4
G 4
CONTROL CHANNEL (TDMA MODE)

Fig. 36

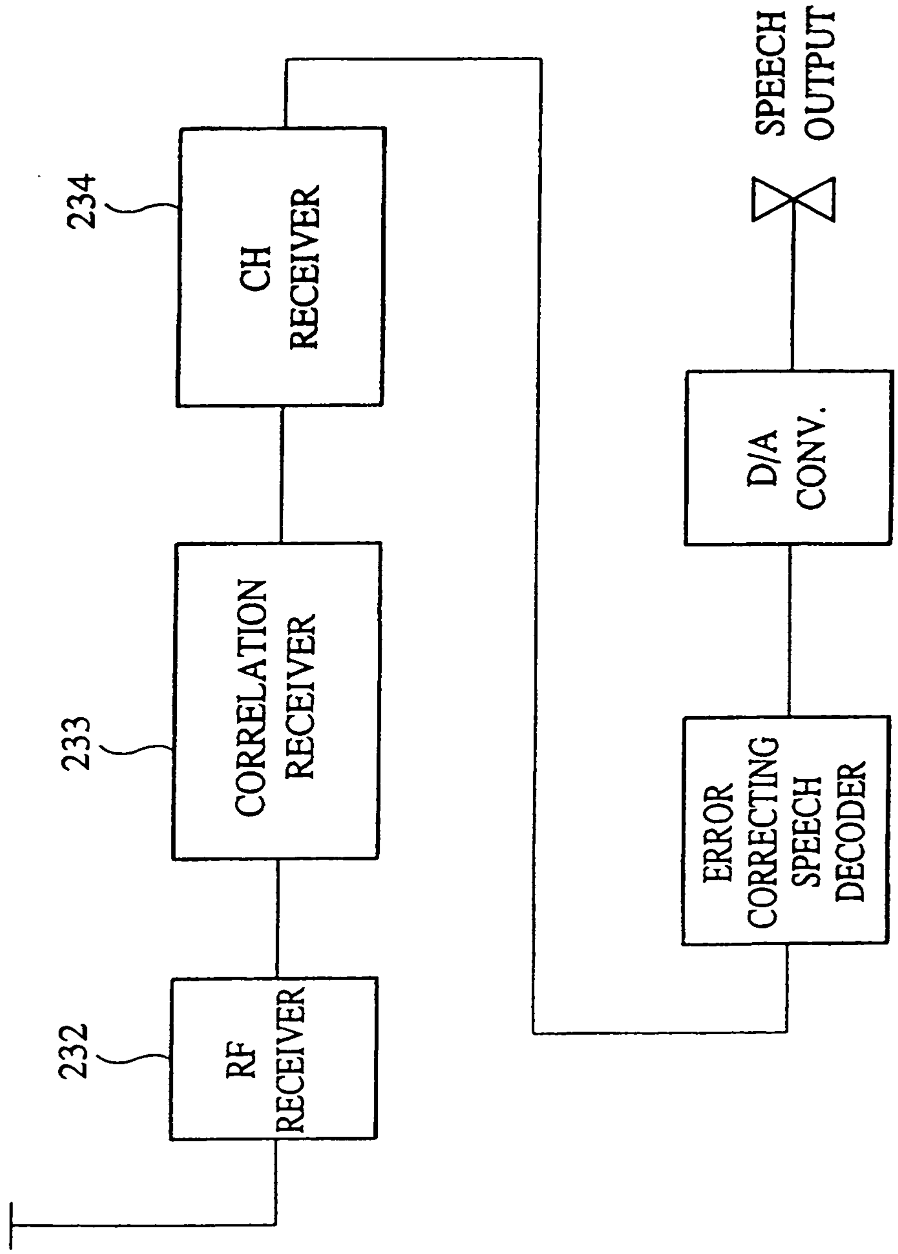

232
RF RECEIVER
233
CORRELATION RECEIVER
234
CH RECEIVER
ERROR CORRECTING SPEECH DECODER
D/A CONV.
SPEECH OUTPUT

Fig. 37

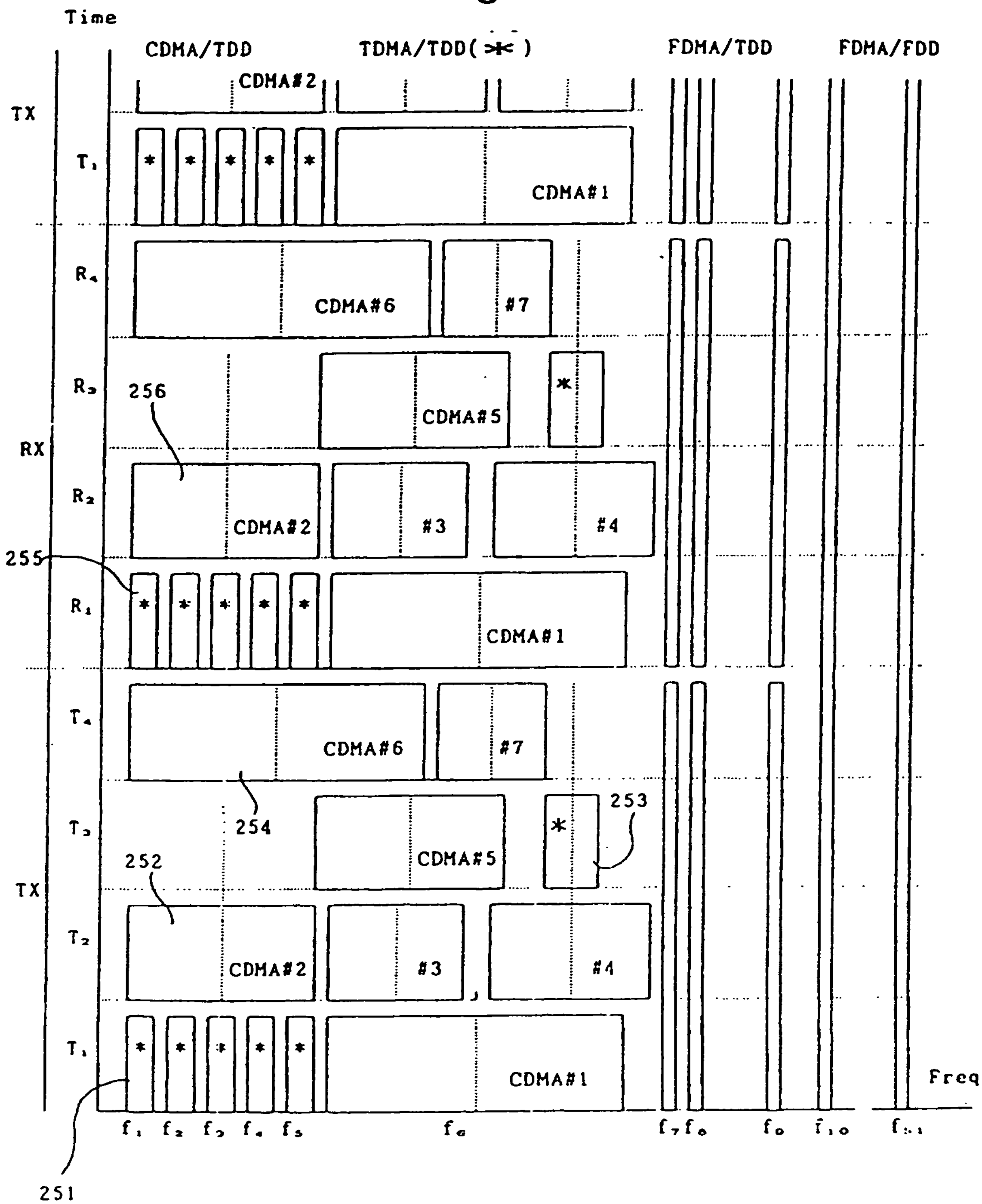

Time
CDMA/TDD
TDMA/TDD(*)
FDMA/TDD
FDMA/FDD
CDMA#2
TX
T1
CDMA#1
R4
CDMA#6
#7
R3
256
CDMA#5
RX
R2
CDMA#2
#3
#4
255
R1
CDMA#1
T4
CDMA#6
#7
253
T3
254
252
CDMA#5
TX
T2
CDMA#2
#3
#4
T1
CDMA#1
Freq.
f1 f2 f3 f4 f5 f6 f7 f8 f9 f10 f11
251

Fig.38

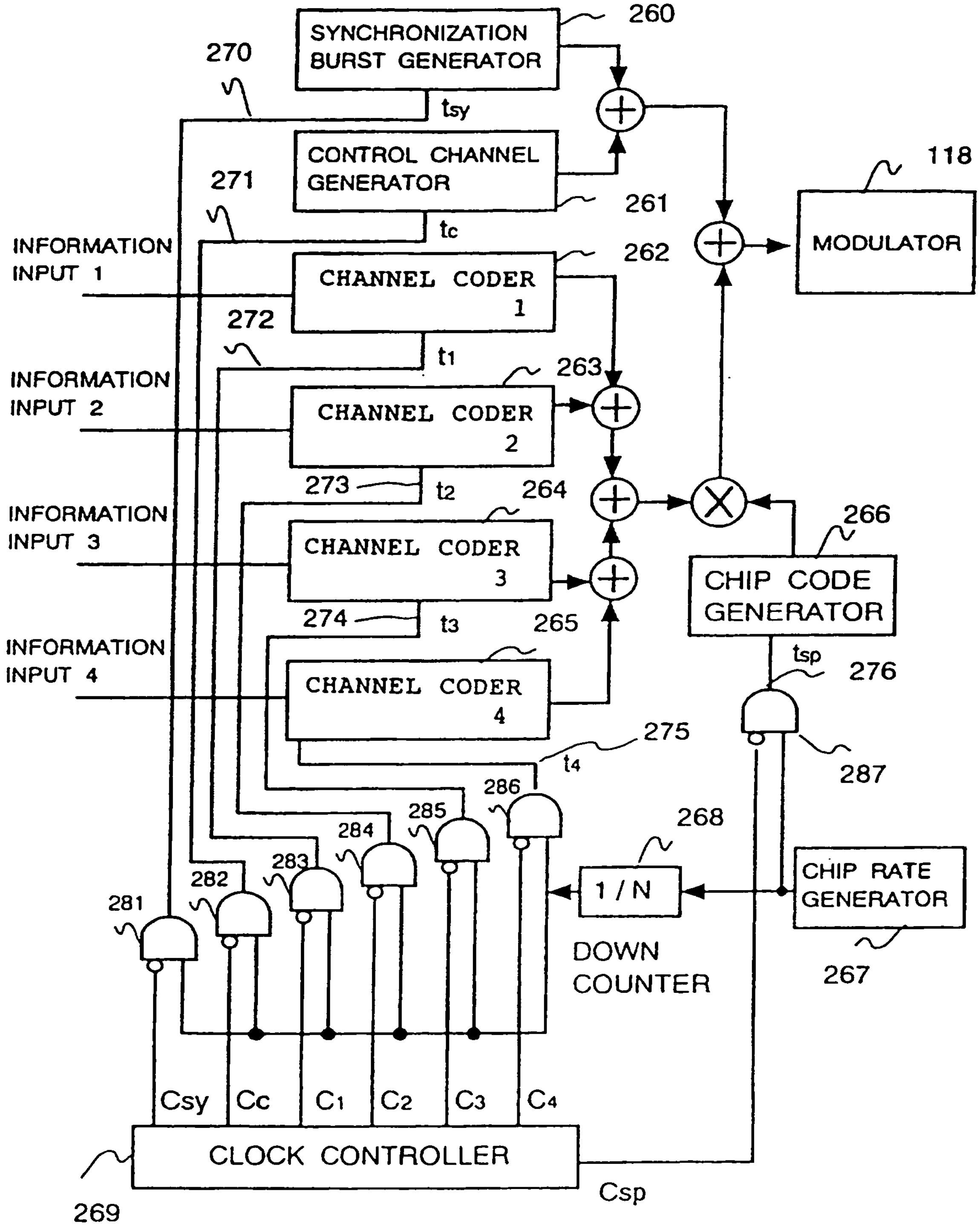

SYNCHRONIZATION BURST GENERATOR
260
270
tsy
CONTROL CHANNEL GENERATOR
271
261
tc
118
MODULATOR
INFORMATION INPUT 1
CHANNEL CODER 1
262
272
t1
INFORMATION INPUT 2
CHANNEL CODER 2
263
273
t2
264
INFORMATION INPUT 3
CHANNEL CODER 3
266
CHIP CODE GENERATOR
274
t3
265
INFORMATION INPUT 4
CHANNEL CODER 4
tsp
276
275
t4
287
286
268
285
284
283
282
281
1 / N
CHIP RATE GENERATOR
DOWN COUNTER
267
Csy
Cc
C1
C2
C3
C4
CLOCK CONTROLLER
269
Csp

Fig. 39

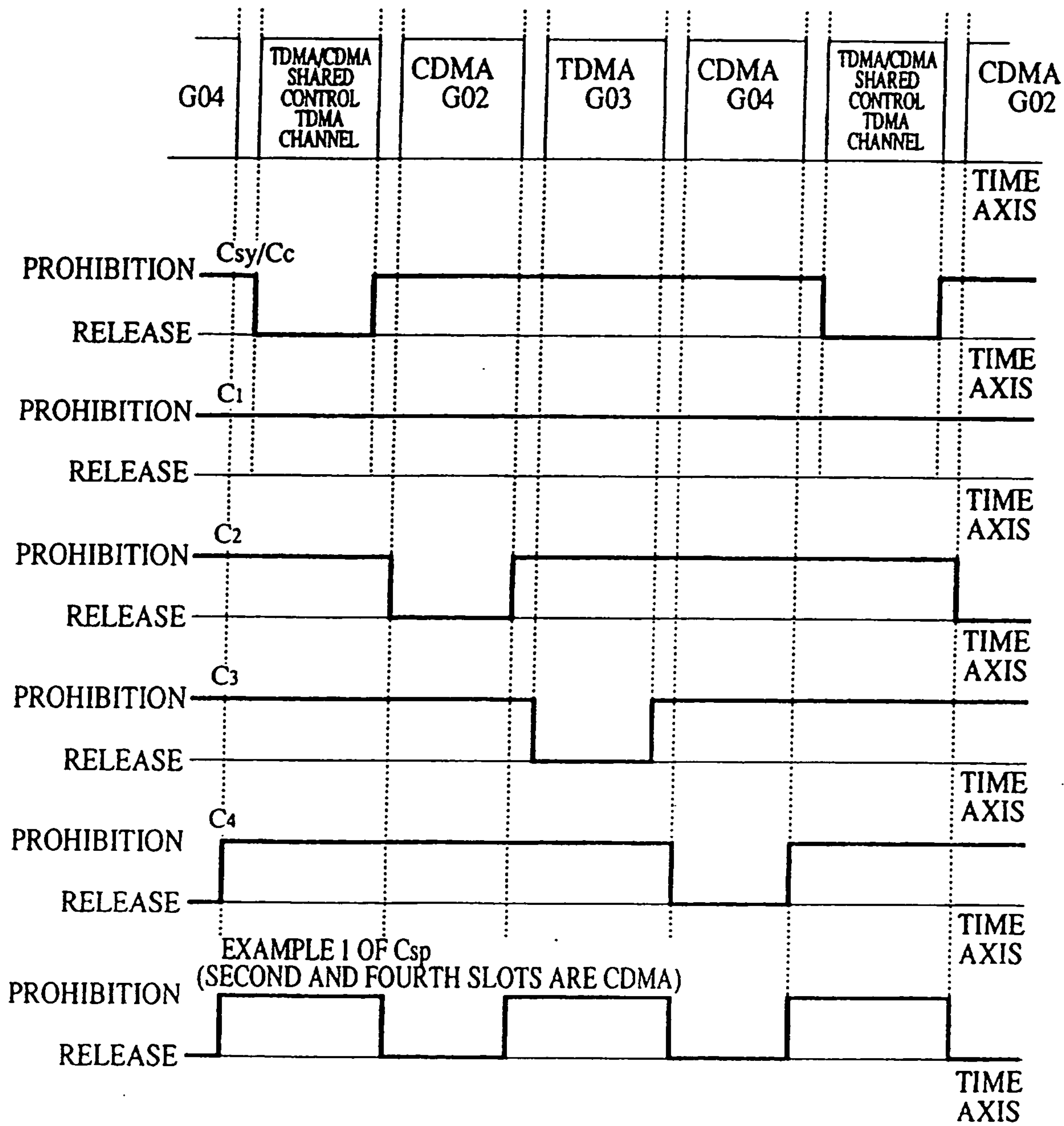

G04
TDMA/CDMA SHARED CONTROL TDMA CHANNEL
CDMA G02
TDMA G03
CDMA G04
TDMA/CDMA SHARED CONTROL TDMA CHANNEL
CDMA G02
TIME AXIS
PROHIBITION
RELEASE
Csy/Cc
TIME AXIS
C1
PROHIBITION
RELEASE
TIME AXIS
C2
PROHIBITION
RELEASE
TIME AXIS
C3
PROHIBITION
RELEASE
TIME AXIS
C4
PROHIBITION
RELEASE
TIME AXIS
EXAMPLE 1 OF Csp
(SECOND AND FOURTH SLOTS ARE CDMA)
PROHIBITION
RELEASE
TIME AXIS

Fig. 40

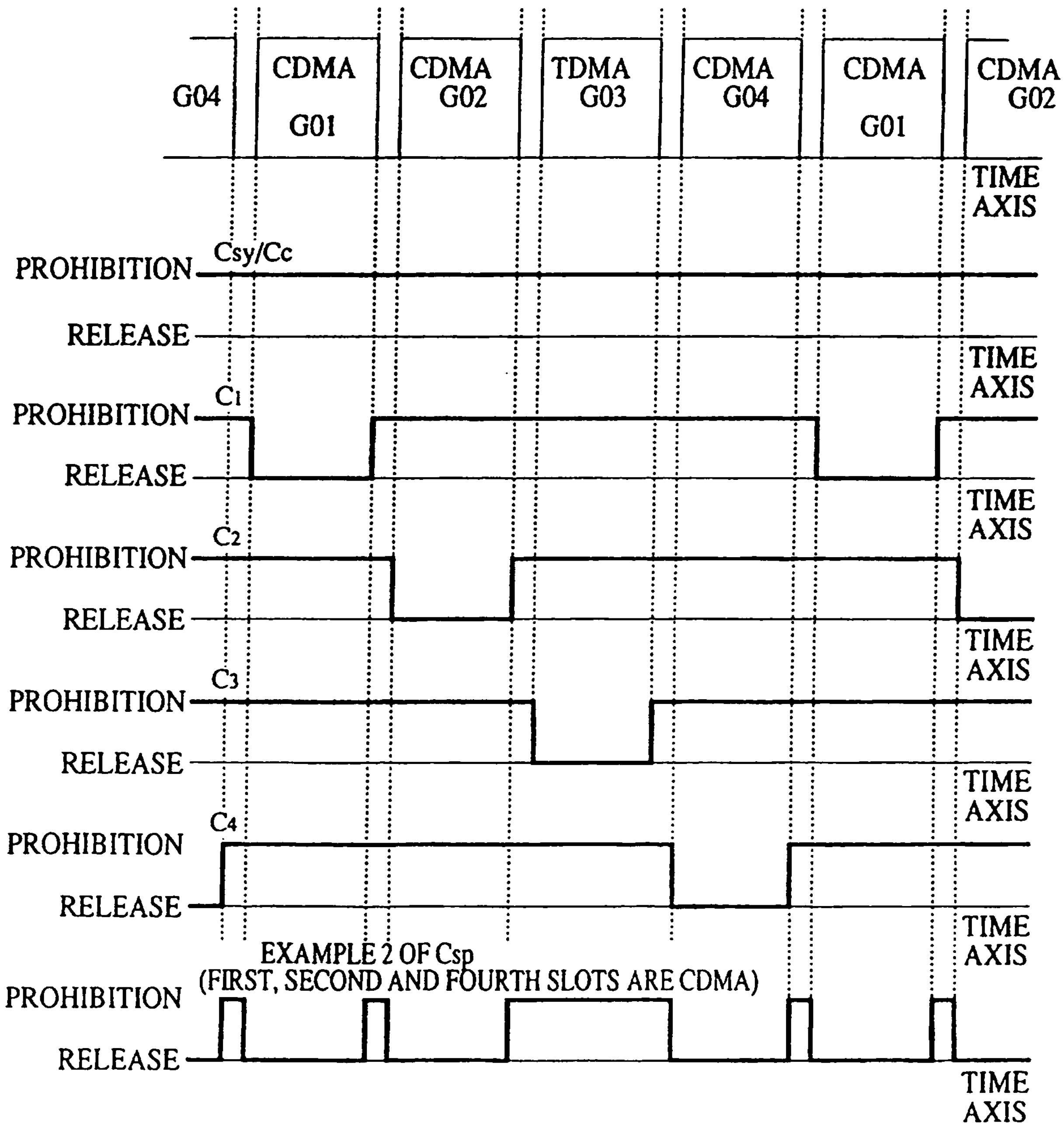

G04
CDMA G01
CDMA G02
TDMA G03
CDMA G04
CDMA G01
CDMA G02
TIME AXIS
PROHIBITION
Csy/Cc
RELEASE
TIME AXIS
C1
PROHIBITION
RELEASE
TIME AXIS
C2
PROHIBITION
RELEASE
TIME AXIS
C3
PROHIBITION
RELEASE
TIME AXIS
C4
PROHIBITION
RELEASE
TIME AXIS
EXAMPLE 2 OF Csp
(FIRST, SECOND AND FOURTH SLOTS ARE CDMA)
PROHIBITION
RELEASE
TIME AXIS

Fig.41

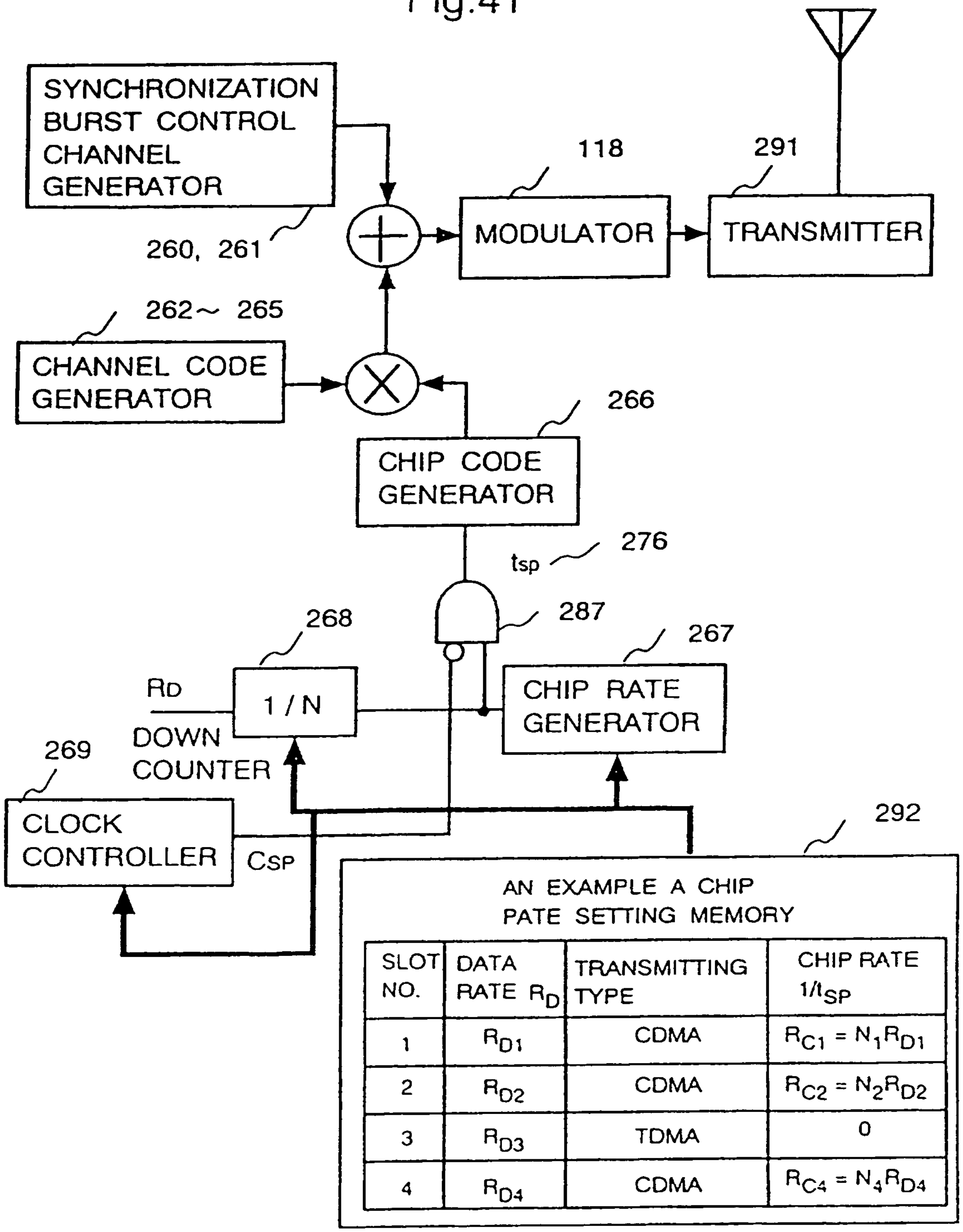

SYNCHRONIZATION BURST CONTROL CHANNEL GENERATOR
260, 261
118
MODULATOR
291
TRANSMITTER
262~ 265
CHANNEL CODE GENERATOR
266
CHIP CODE GENERATOR
tsp
276
287
268
267
RD
1 / N
DOWN COUNTER
CHIP RATE GENERATOR
269
CLOCK CONTROLLER
CSP
292
AN EXAMPLE A CHIP PATE SETTING MEMORY
SLOT NO.
DATA RATE R_D
TRANSMITTING TYPE
CHIP RATE $1/t_{SP}$
1
R_{D1}
CDMA
$R_{C1} = N_1R_{D1}$
2
R_{D2}
CDMA
$R_{C2} = N_2R_{D2}$
3
R_{D3}
TDMA
0
4
R_{D4}
CDMA
$R_{C4} = N_4R_{D4}$

Fig.42

AN EXAMPLE OF CHIP RATE

SLOT NO.	DATA RATE R_D (bps)	TRANSMITTING TYPE	CHIP RATE $1/t_{SP}$ (cps)
1	19.2K	CDMA	12.288M
2	9.6K	CDMA	6.144M
3	192K	TDMA	0
4	19.2K	CDMA	12.288M

Fig.43

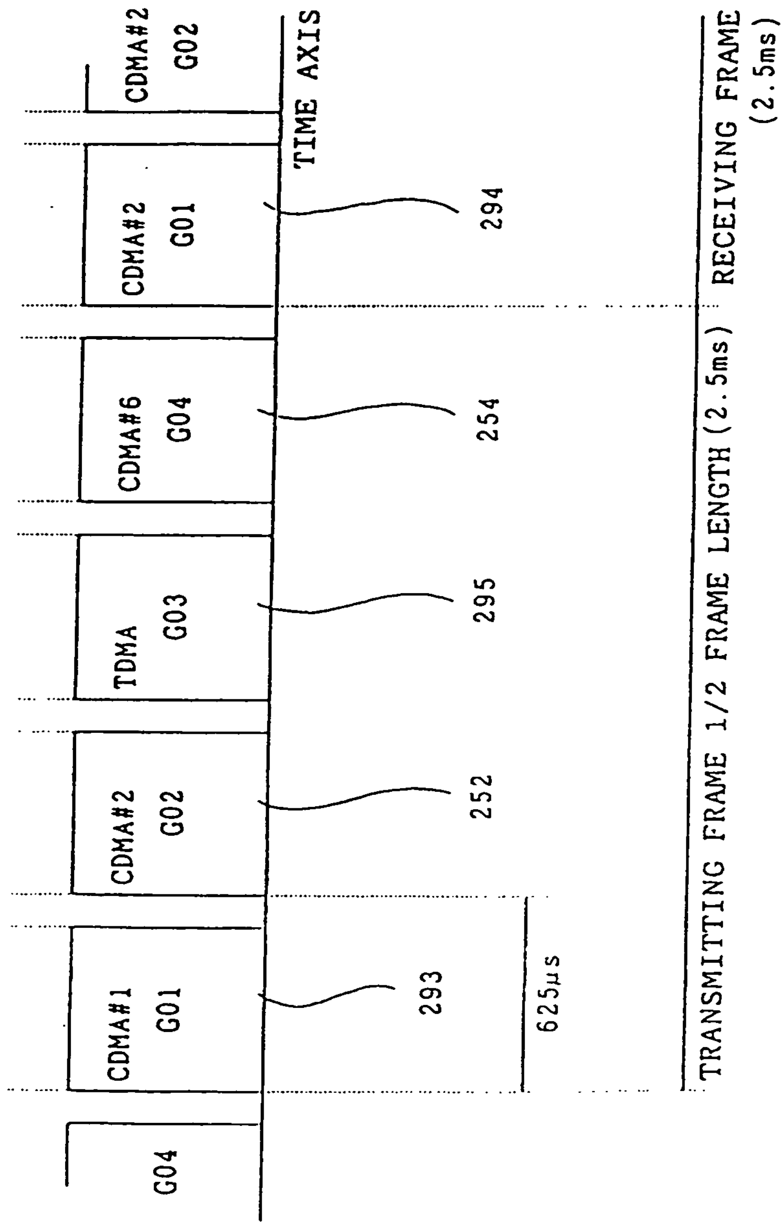

G04
CDMA#1
G01
CDMA#2
G02
TDMA
G03
CDMA#6
G04
CDMA#2
G01
CDMA#2
G02
TIME AXIS
293
252
295
254
294
625μs
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME
(2.5ms)

Fig.44

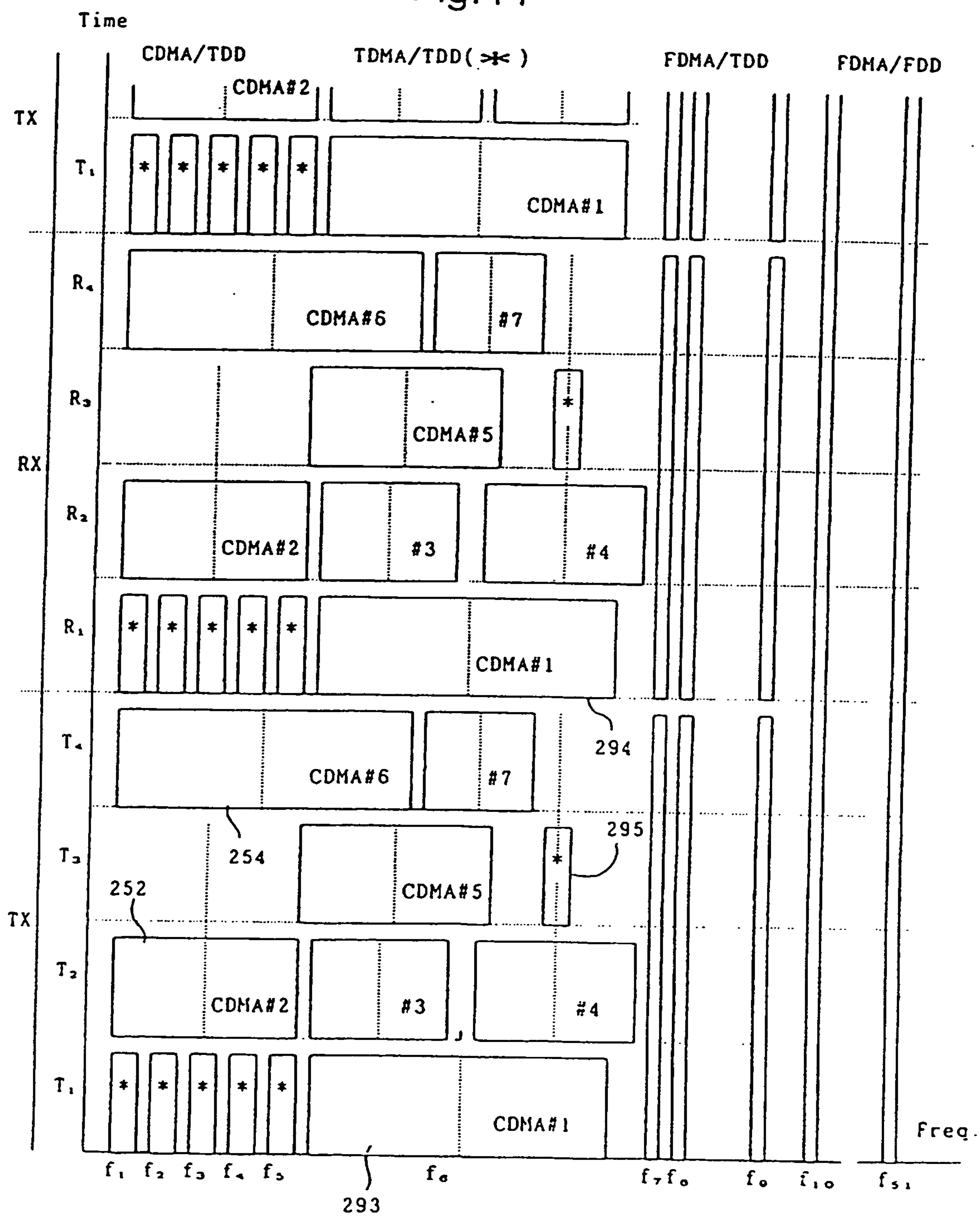

Time
CDMA/TDD
TDMA/TDD(※)
FDMA/TDD
FDMA/FDD
CDMA#2
TX
T_1
CDMA#1
R_4
CDMA#6
#7
R_3
CDMA#5
RX
R_2
CDMA#2
#3
#4
R_1
CDMA#1
294
T_4
CDMA#6
#7
295
T_3
254
252
CDMA#5
TX
T_2
CDMA#2
#3
#4
T_1
CDMA#1
Freq.
f_1 f_2 f_3 f_4 f_5
f_6
f_7 f_8
f_9 f_{10}
f_{51}
293

Fig.45

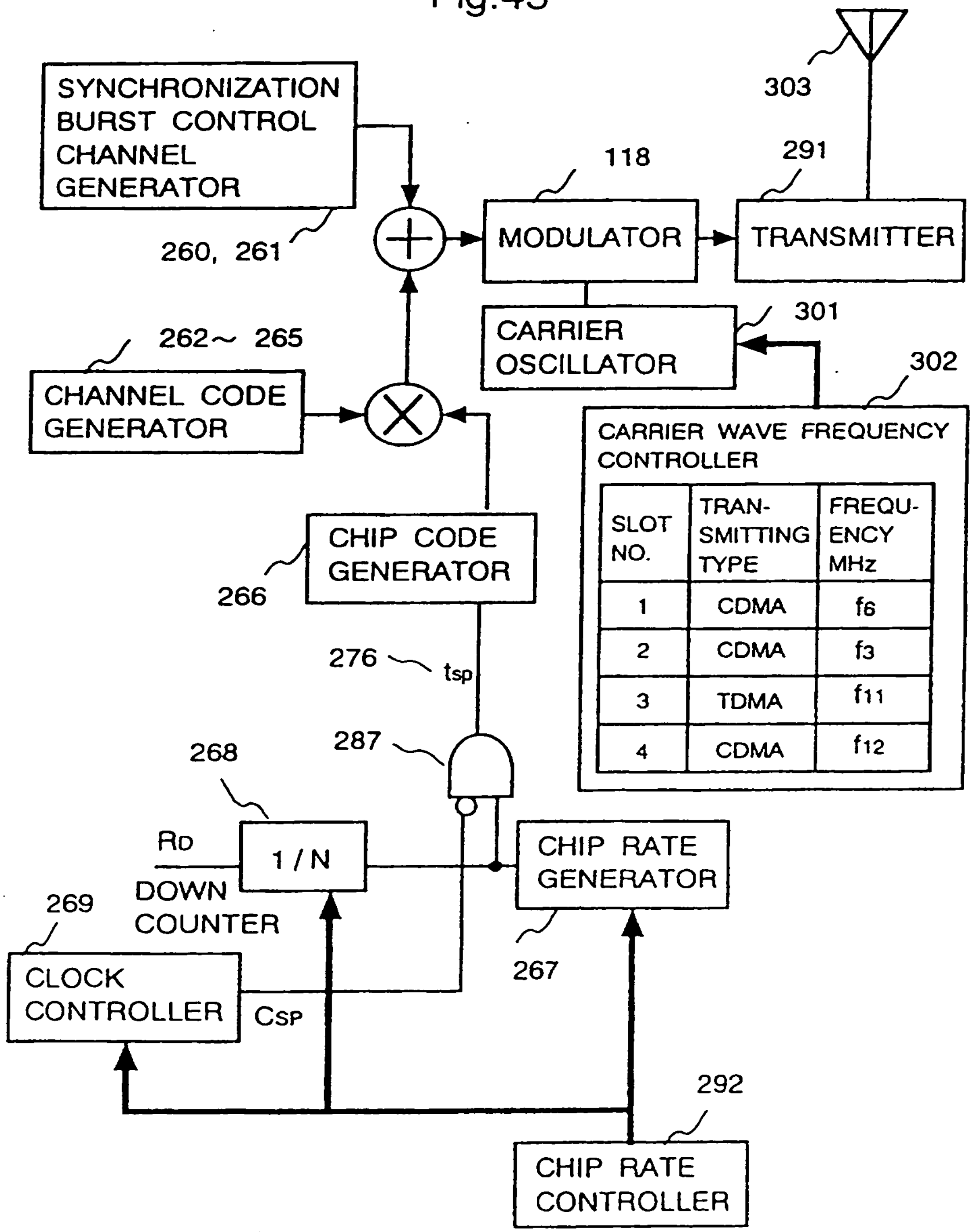

SYNCHRONIZATION BURST CONTROL CHANNEL GENERATOR
260, 261
303
291
118
MODULATOR
TRANSMITTER
CARRIER OSCILLATOR
301
302
262~ 265
CHANNEL CODE GENERATOR
CARRIER WAVE FREQUENCY CONTROLLER
SLOT NO.
TRAN-SMITTING TYPE
FREQU-ENCY MHz
1
CDMA
f6
2
CDMA
f3
3
TDMA
f11
4
CDMA
f12
CHIP CODE GENERATOR
266
276
tsp
287
268
RD
1 / N
DOWN COUNTER
CHIP RATE GENERATOR
269
CLOCK CONTROLLER
CSP
267
292
CHIP RATE CONTROLLER

Fig. 46

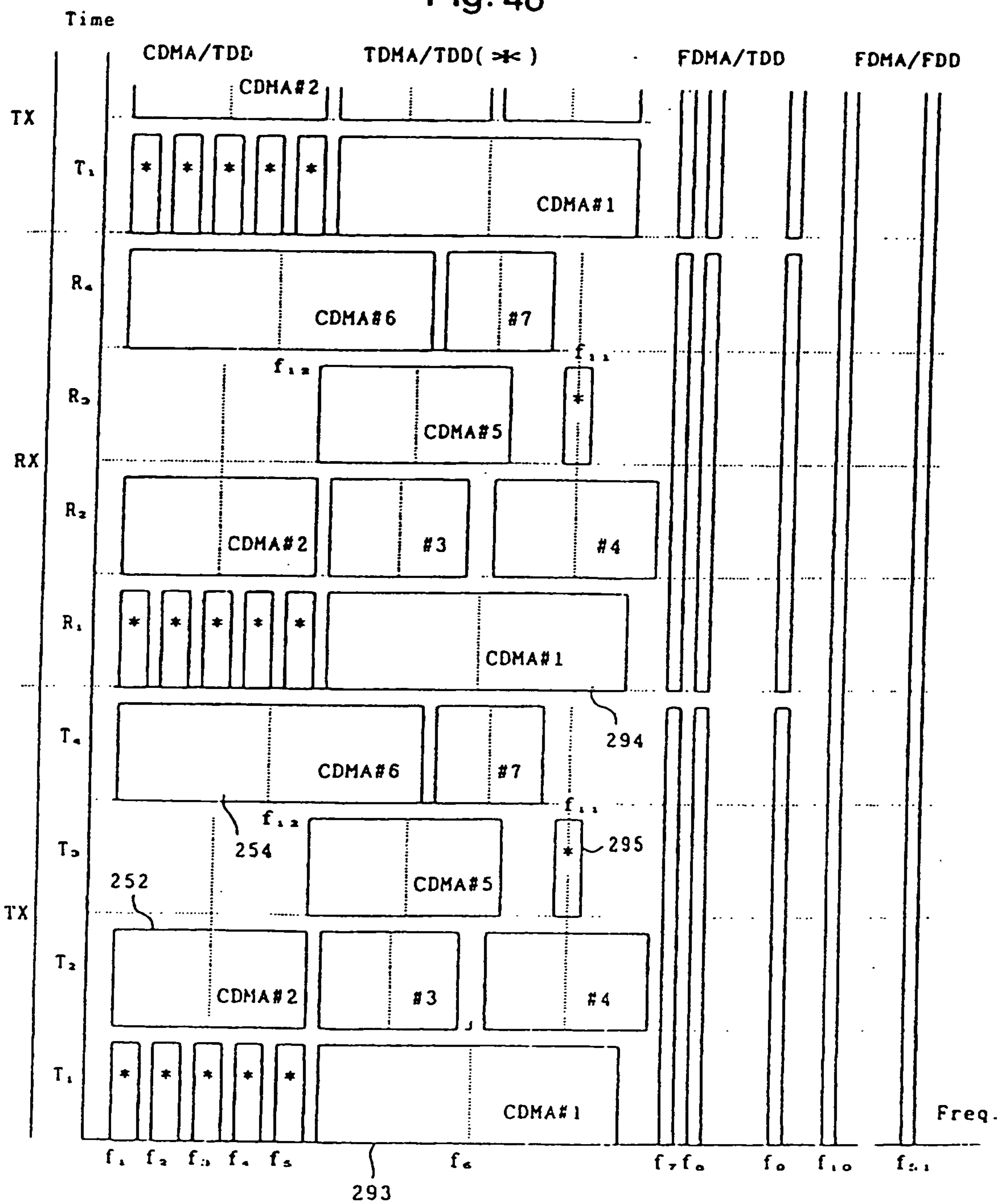

Time
CDMA/TDD
TDMA/TDD(*)
FDMA/TDD
FDMA/FDD
CDMA#2
TX
T_1
CDMA#1
R_4
CDMA#6
#7
f_{11}
f_{12}
R_3
CDMA#5
RX
R_2
CDMA#2
#3
#4
R_1
CDMA#1
294
T_4
CDMA#6
#7
f_{11}
f_{12}
T_3
254
295
CDMA#5
252
TX
T_2
CDMA#2
#3
#4
T_1
CDMA#1
Freq.
f_1 f_2 f_3 f_4 f_5 f_6 f_7 f_8 f_9 f_{10} f_{11}
293

Fig.47

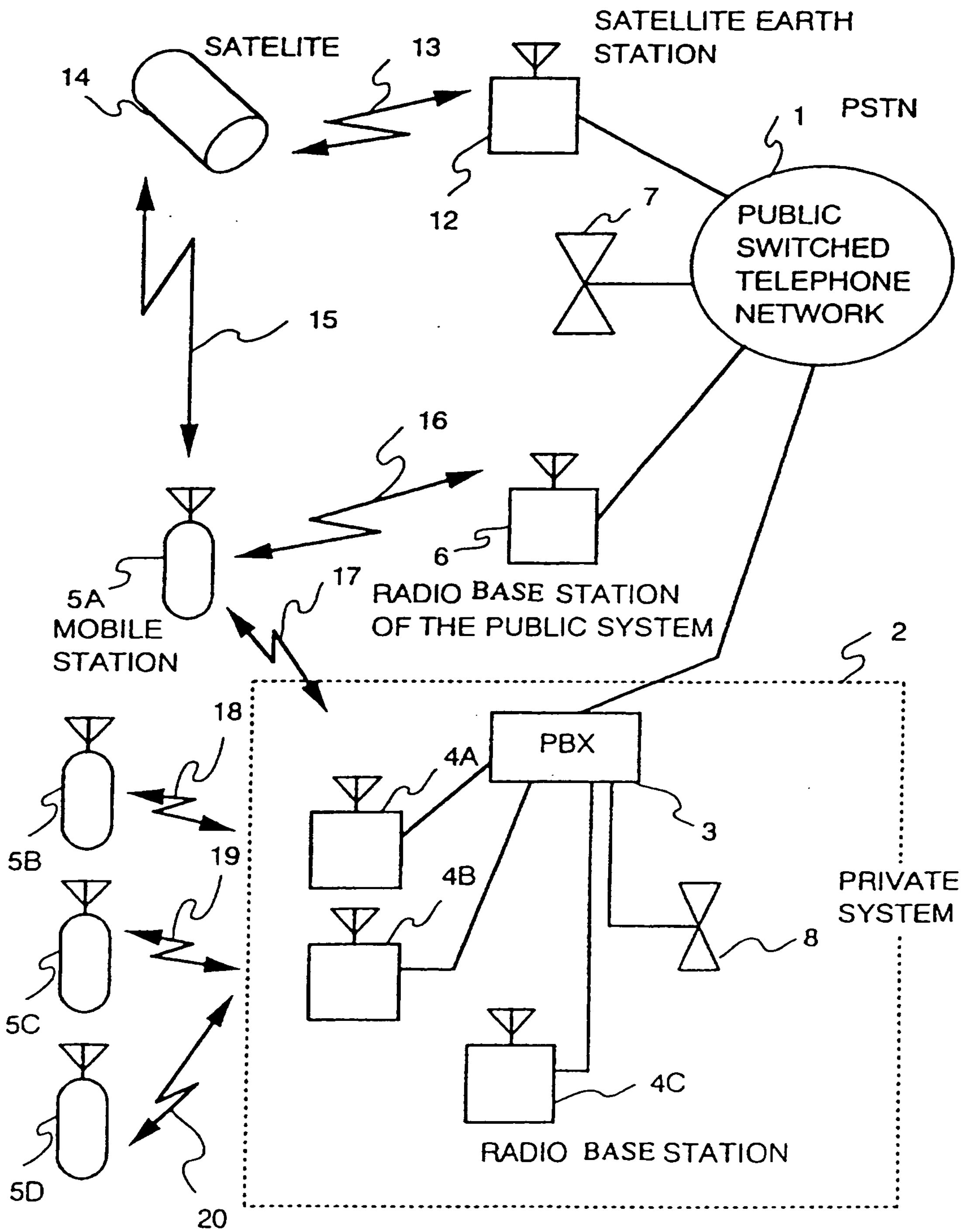

SATELITE
14
13
SATELLITE EARTH
STATION
12
1
PSTN
7
PUBLIC
SWITCHED
TELEPHONE
NETWORK
15
16
6
5A
MOBILE
STATION
17
RADIO BASE STATION
OF THE PUBLIC SYSTEM
2
18
PBX
4A
3
5B
19
4B
PRIVATE
SYSTEM
8
5C
4C
5D
RADIO BASE STATION
20

Fig.48

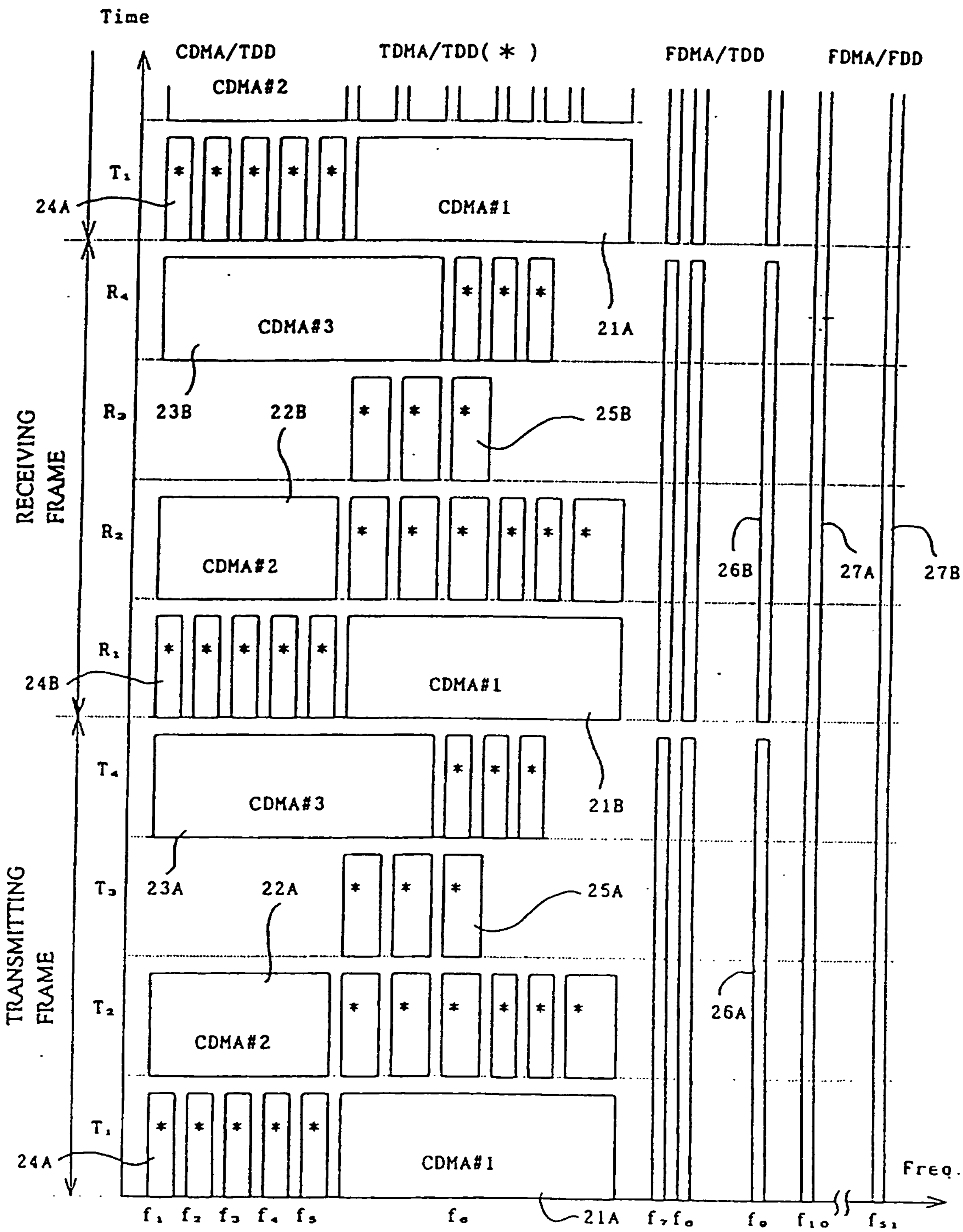

Time
CDMA/TDD
TDMA/TDD(*)
FDMA/TDD
FDMA/FDD
CDMA#2
T1
24A
CDMA#1
R4
CDMA#3
21A
R3
23B
22B
25B
RECEIVING FRAME
R2
CDMA#2
26B
27A
27B
R1
24B
CDMA#1
T4
CDMA#3
21B
T3
23A
22A
25A
TRANSMITTING FRAME
T2
CDMA#2
26A
T1
24A
CDMA#1
Freq.
f1 f2 f3 f4 f5
f6
21A
f7 f8
f9
f10
f11

Fig. 49

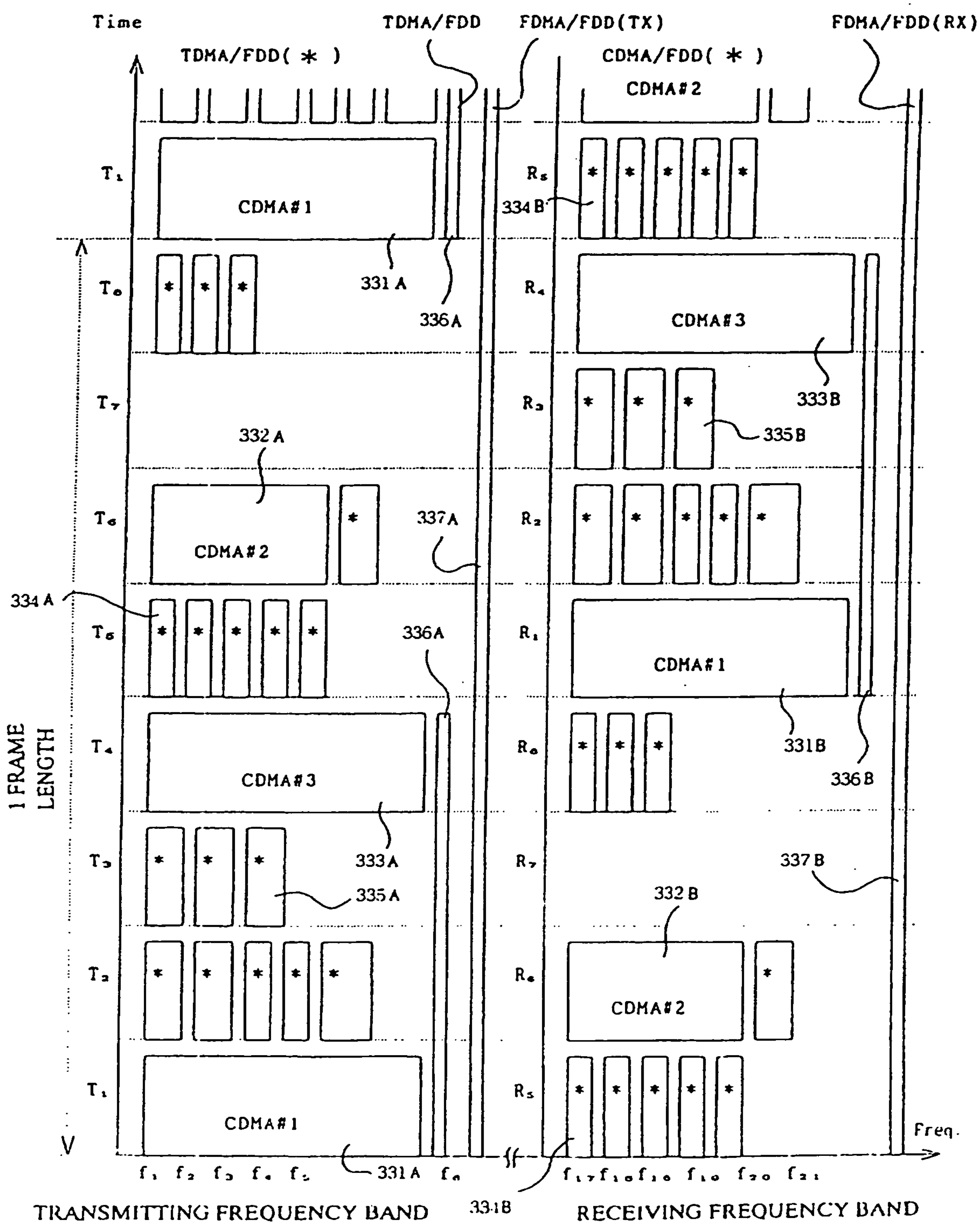

Time
TDMA/FDD
FDMA/FDD(TX)
FDMA/FDD(RX)
TDMA/FDD(*)
CDMA/FDD(*)
CDMA#2
CDMA#1
CDMA#3
CDMA#2
CDMA#1
CDMA#3
CDMA#1
CDMA#2
CDMA#1
331A
336A
332A
337A
334A
336A
333A
335A
331A
334B
333B
335B
331B
336B
337B
332B
331B
1 FRAME LENGTH
Freq.
TRANSMITTING FREQUENCY BAND
RECEIVING FREQUENCY BAND

Fig.50

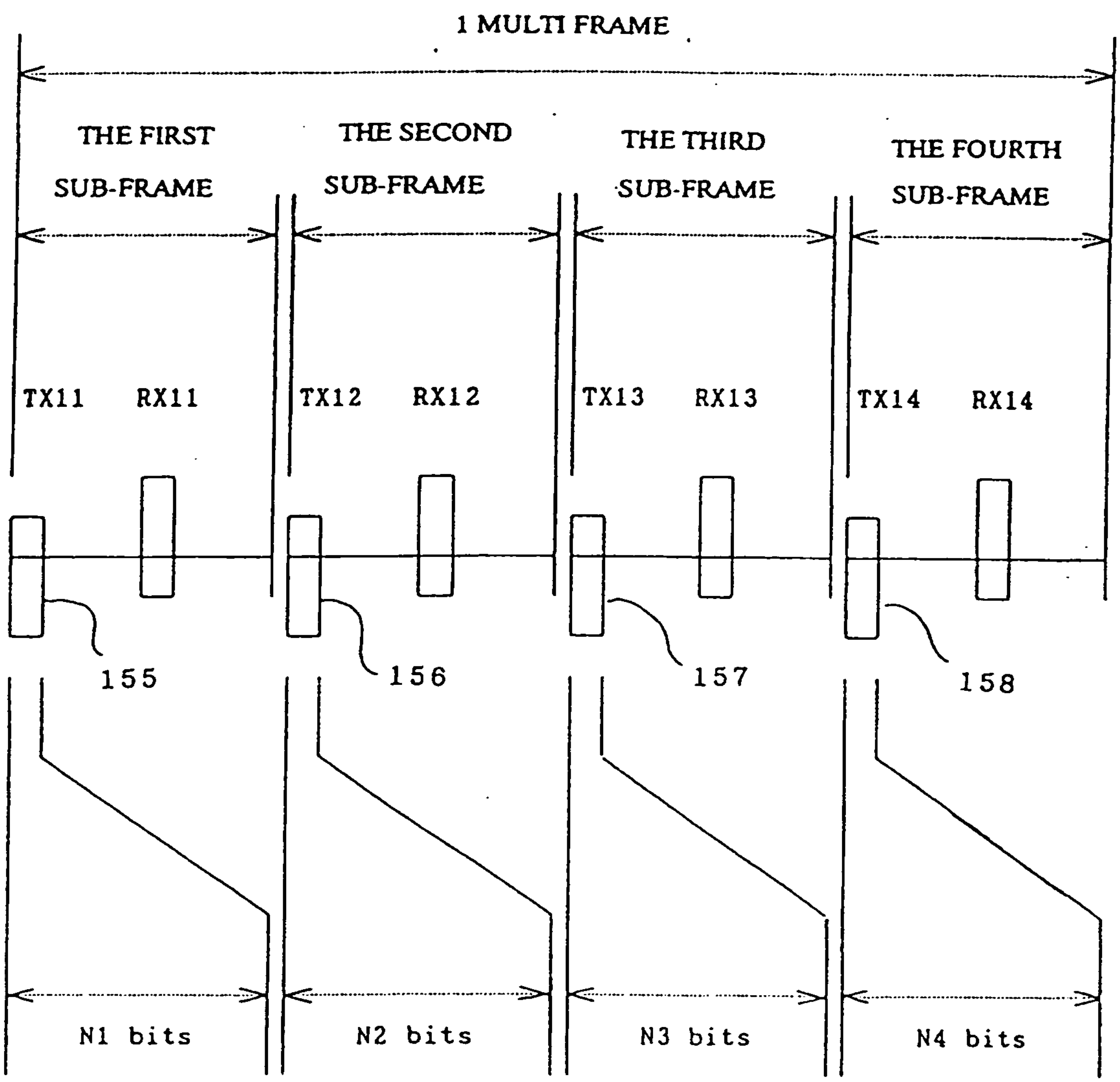

1 MULTI FRAME
THE FIRST SUB-FRAME
THE SECOND SUB-FRAME
THE THIRD SUB-FRAME
THE FOURTH SUB-FRAME
TX11
RX11
TX12
RX12
TX13
RX13
TX14
RX14
155
156
157
158
N1 bits
N2 bits
N3 bits
N4 bits

Fig.51

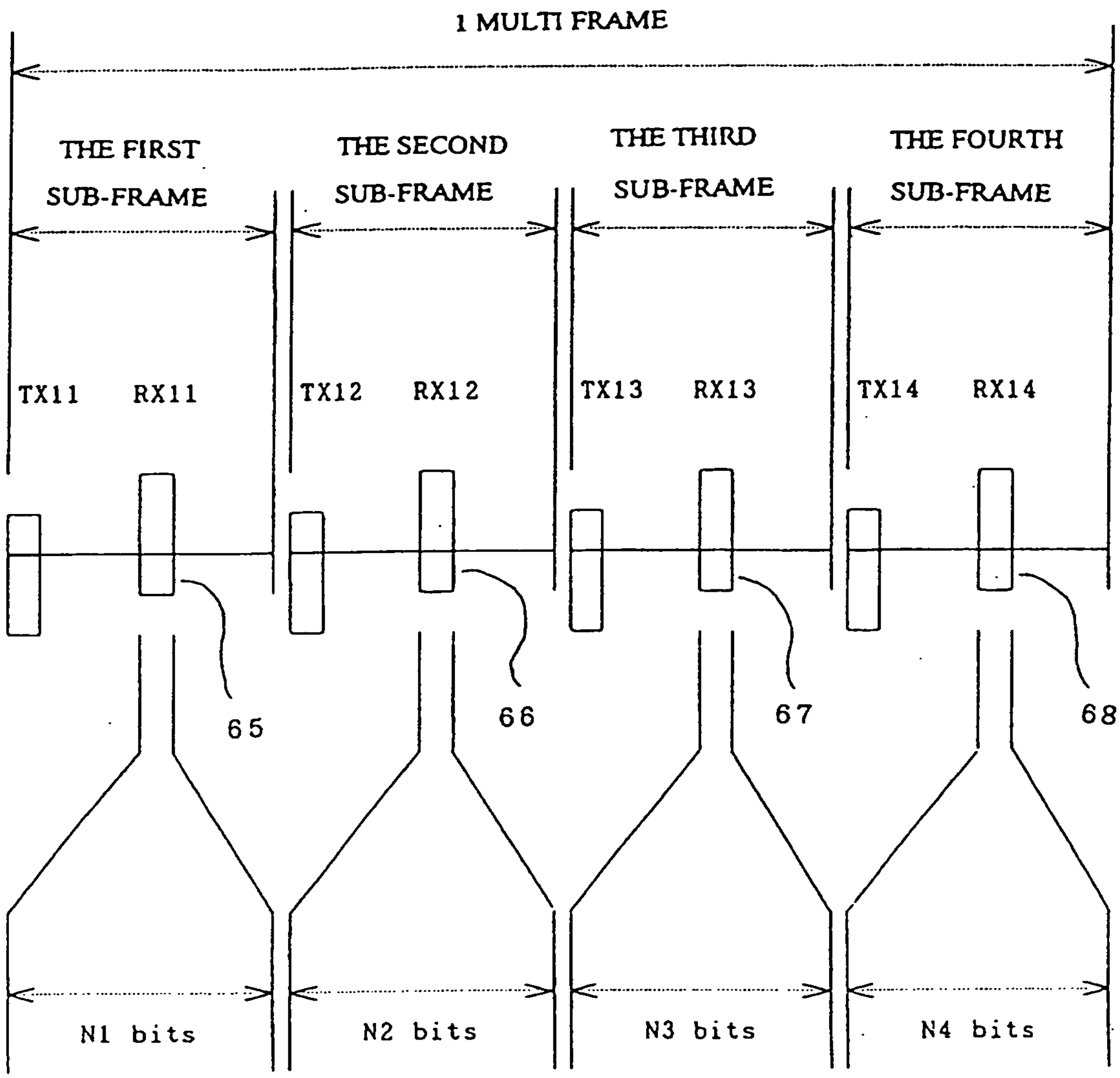

1 MULTI FRAME
THE FIRST SUB-FRAME
THE SECOND SUB-FRAME
THE THIRD SUB-FRAME
THE FOURTH SUB-FRAME
TX11
RX11
TX12
RX12
TX13
RX13
TX14
RX14
65
66
67
68
N1 bits
N2 bits
N3 bits
N4 bits

Fig.52

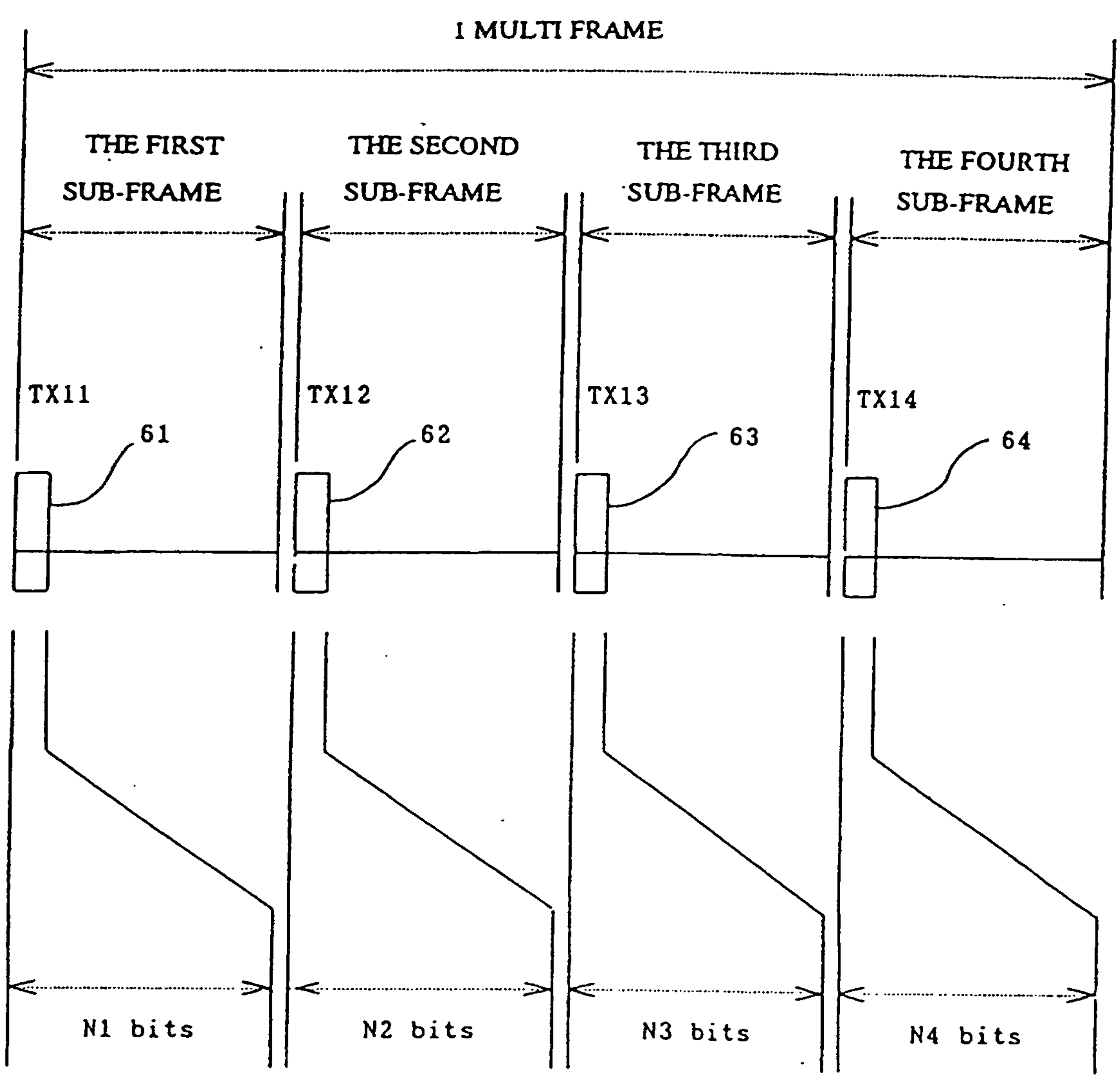

1 MULTI FRAME
THE FIRST SUB-FRAME
THE SECOND SUB-FRAME
THE THIRD SUB-FRAME
THE FOURTH SUB-FRAME
TX11
TX12
TX13
TX14
61
62
63
64
N1 bits
N2 bits
N3 bits
N4 bits

Fig.53

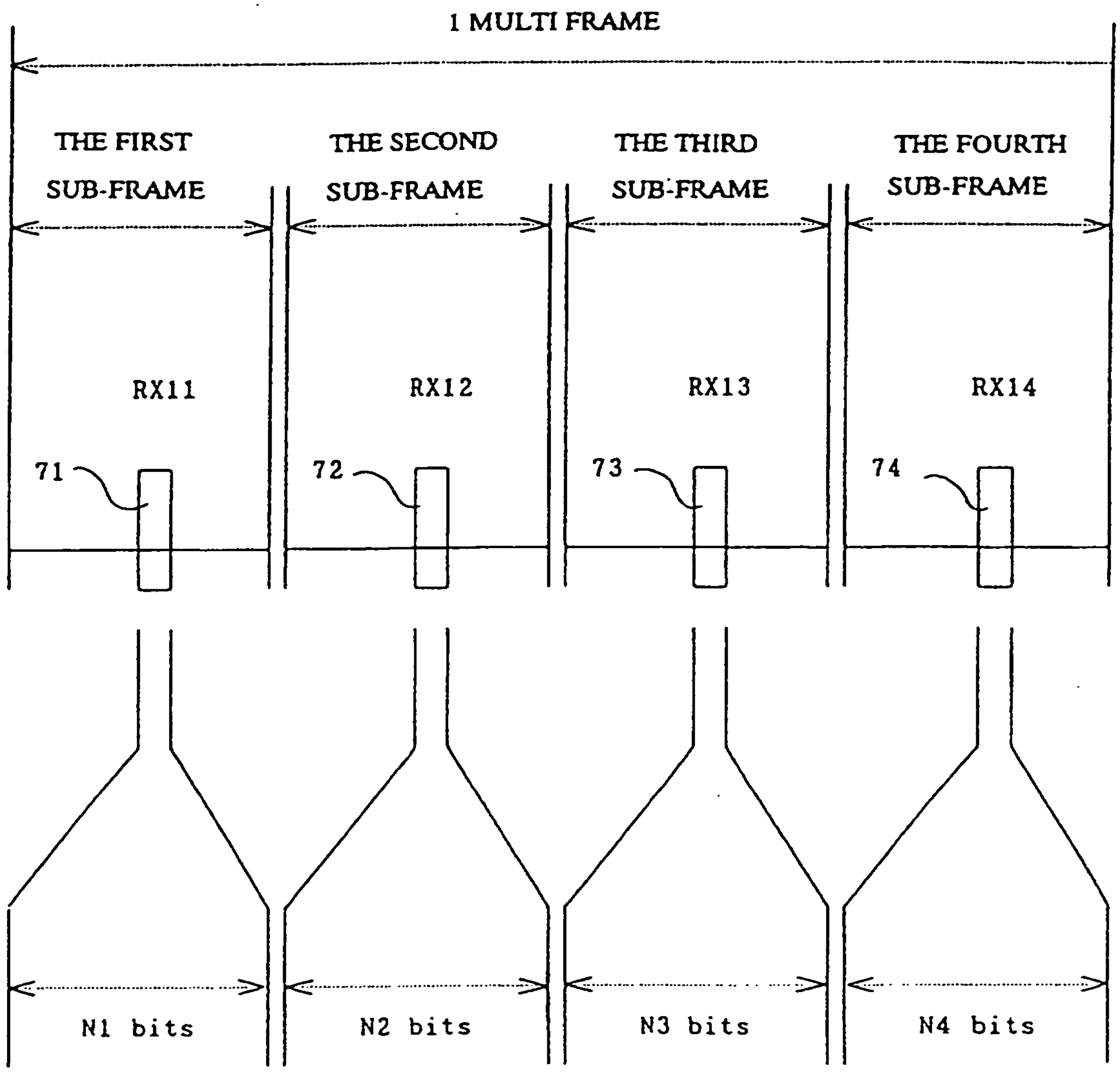

1 MULTI FRAME
THE FIRST SUB-FRAME
THE SECOND SUB-FRAME
THE THIRD SUB-FRAME
THE FOURTH SUB-FRAME
RX11
RX12
RX13
RX14
71
72
73
74
N1 bits
N2 bits
N3 bits
N4 bits

Fig. 54

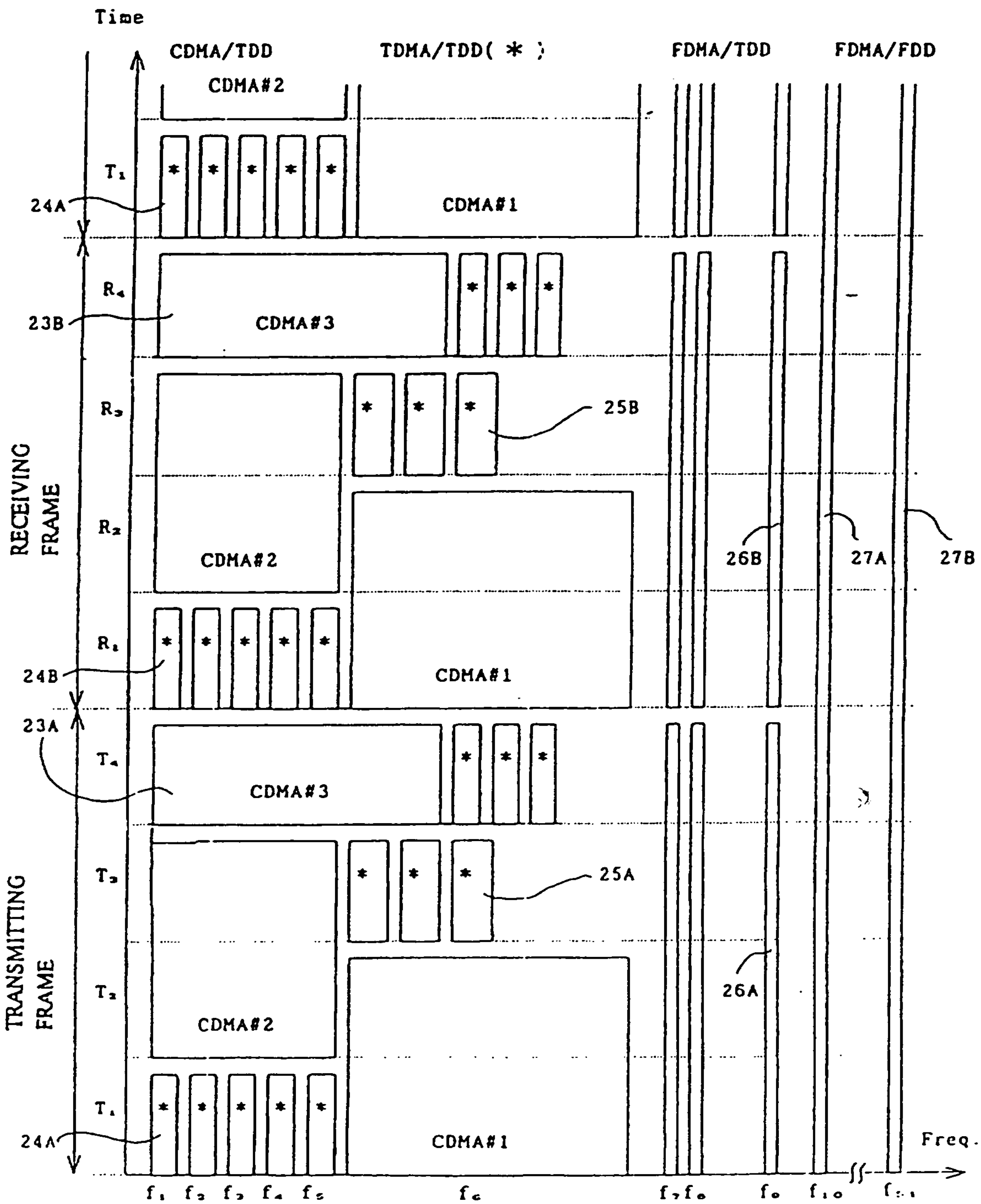

Time
CDMA/TDD
TDMA/TDD(*)
FDMA/TDD
FDMA/FDD
CDMA#2
T1
24A
CDMA#1
R4
23B
CDMA#3
R3
25B
RECEIVING FRAME
R2
CDMA#2
26B
27A
27B
R1
24B
CDMA#1
23A
T4
CDMA#3
T3
25A
TRANSMITTING FRAME
T2
26A
CDMA#2
T1
24A
CDMA#1
Freq.
f1 f2 f3 f4 f5
f6
f7 f8
f9
f10
f11

Fig.55

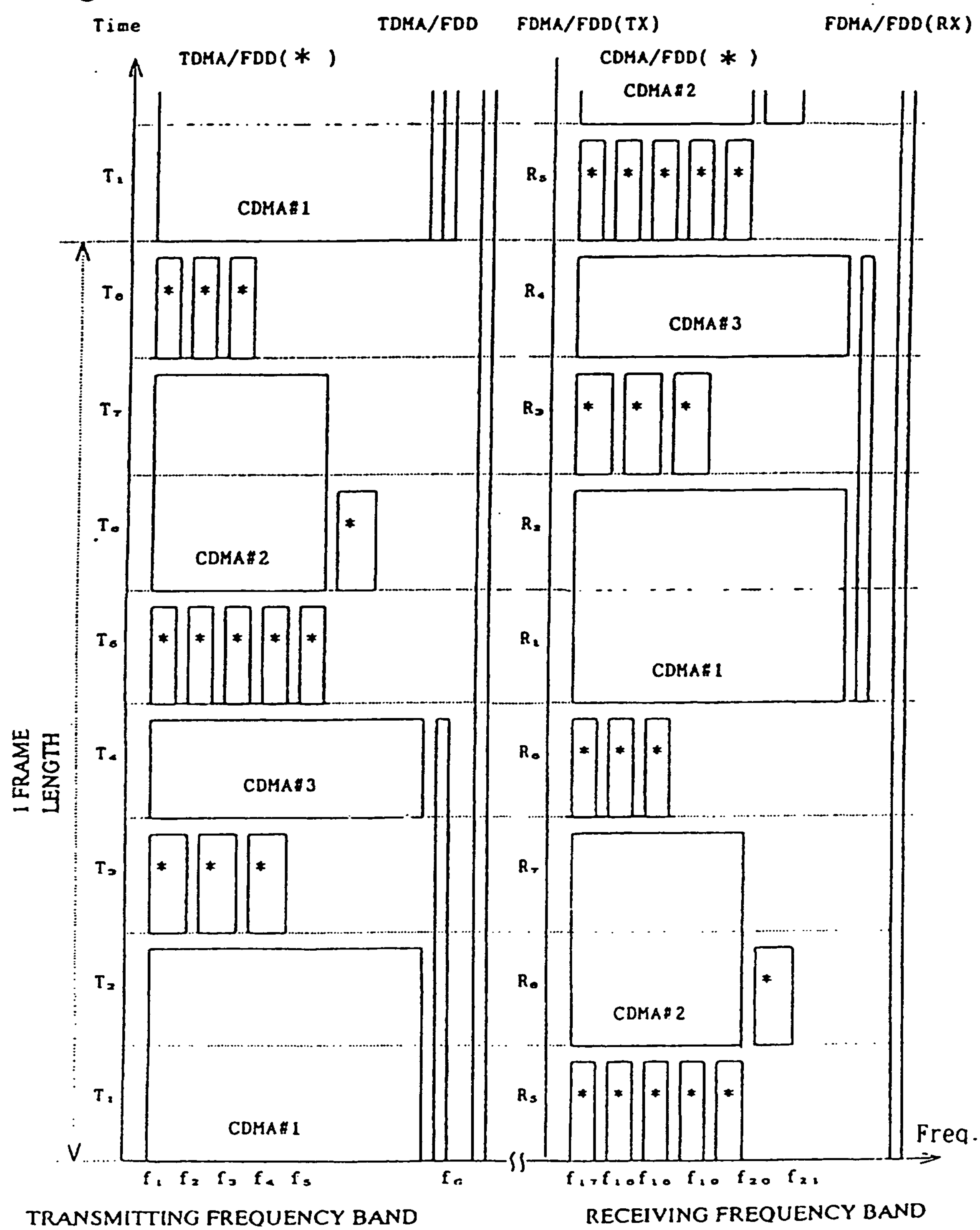

Time
TDMA/FDD
FDMA/FDD(TX)
FDMA/FDD(RX)
TDMA/FDD(*)
CDMA/FDD(*)
CDMA#2
CDMA#1
CDMA#3
CDMA#2
CDMA#1
CDMA#3
CDMA#1
CDMA#2
1 FRAME LENGTH
Freq.
TRANSMITTING FREQUENCY BAND
RECEIVING FREQUENCY BAND

Fig.56

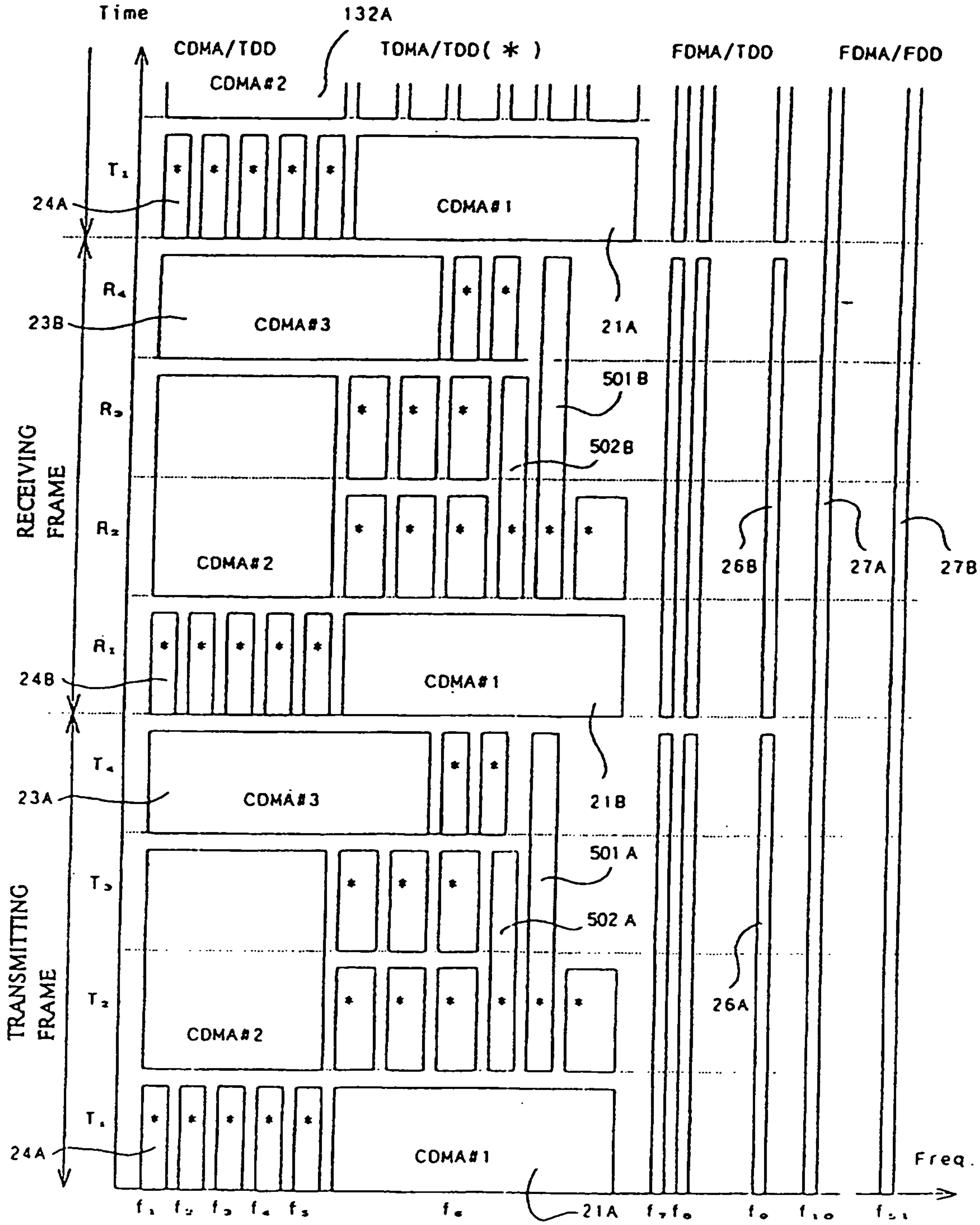

Time
132A
CDMA/TDD
CDMA#2
TDMA/TDD(*)
FDMA/TDD
FDMA/FDD
T1
24A
CDMA#1
R4
23B
CDMA#3
21A
501B
R3
502B
RECEIVING FRAME
R2
CDMA#2
26B
27A
27B
R1
24B
CDMA#1
T4
23A
CDMA#3
21B
501 A
T3
502 A
TRANSMITTING FRAME
T2
CDMA#2
26A
T1
24A
CDMA#1
Freq.
f1 f2 f3 f4 f5
f6
21A
f7 f8
f9
f10
f11

Fig.57

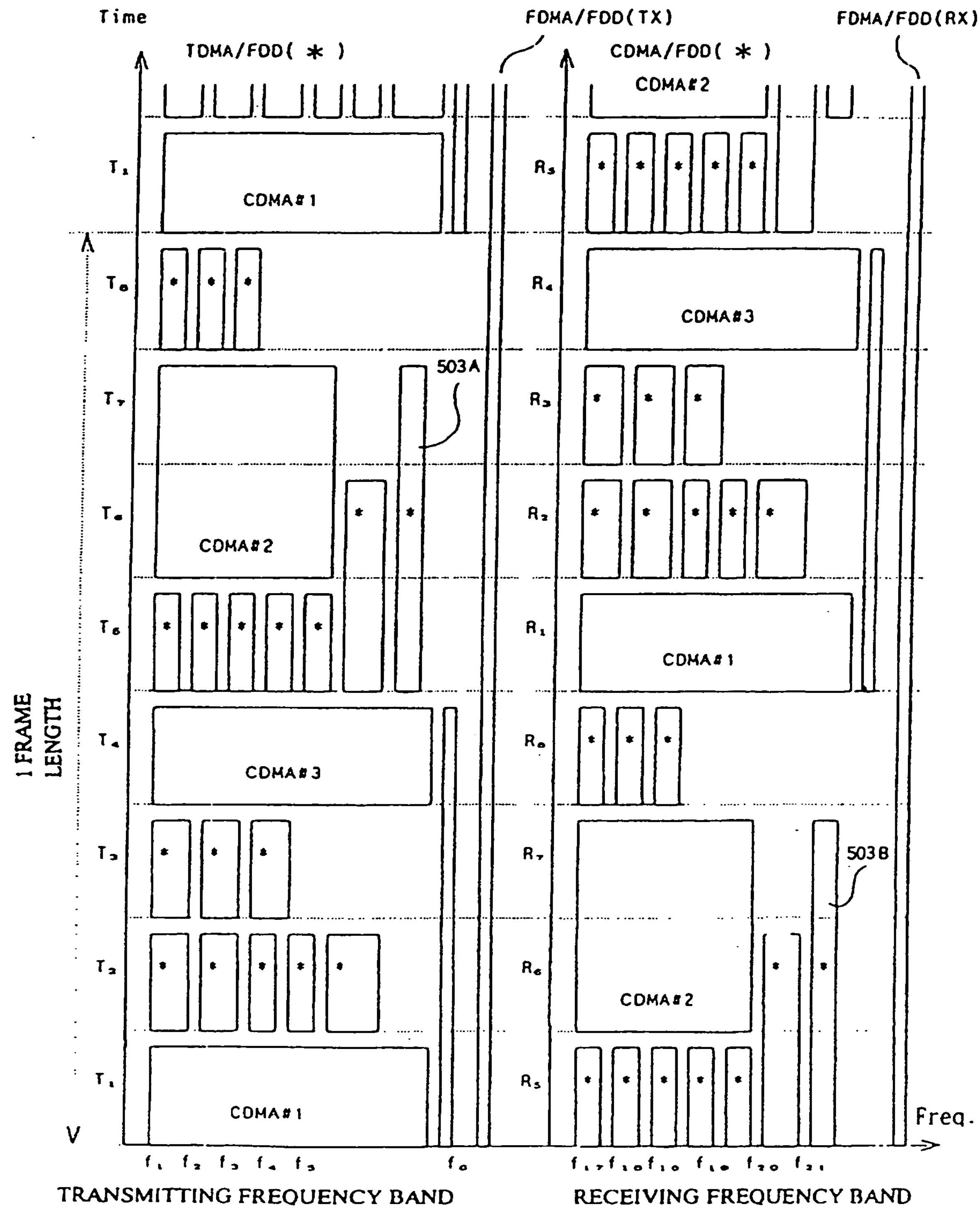

Time
FDMA/FDD(TX)
FDMA/FDD(RX)
TDMA/FDD(*)
CDMA/FDD(*)
CDMA#2
CDMA#1
CDMA#2
CDMA#3
CDMA#1
CDMA#3
CDMA#2
CDMA#1
503A
503B
1 FRAME LENGTH
Freq.
TRANSMITTING FREQUENCY BAND
RECEIVING FREQUENCY BAND

Fig.58

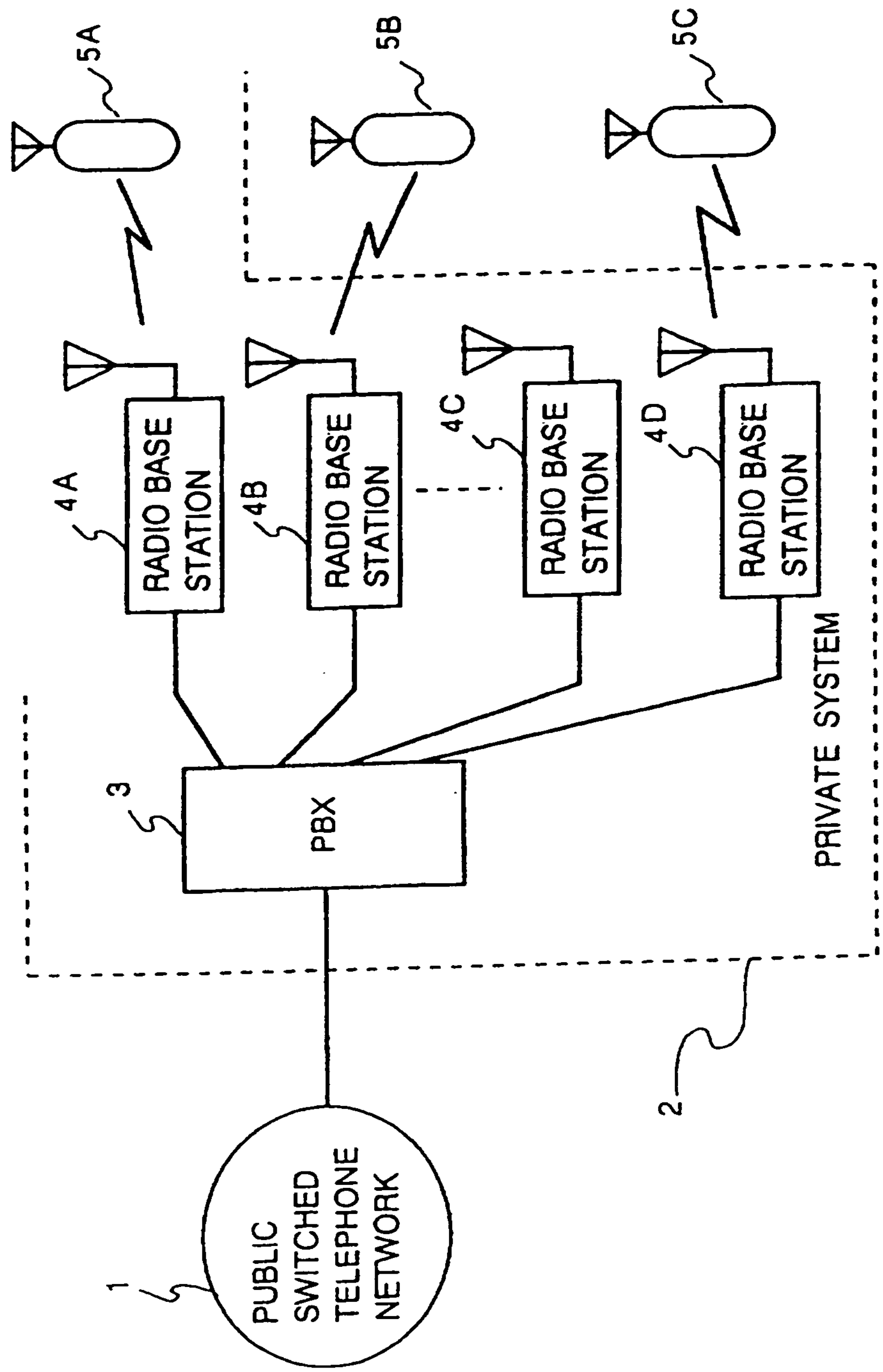
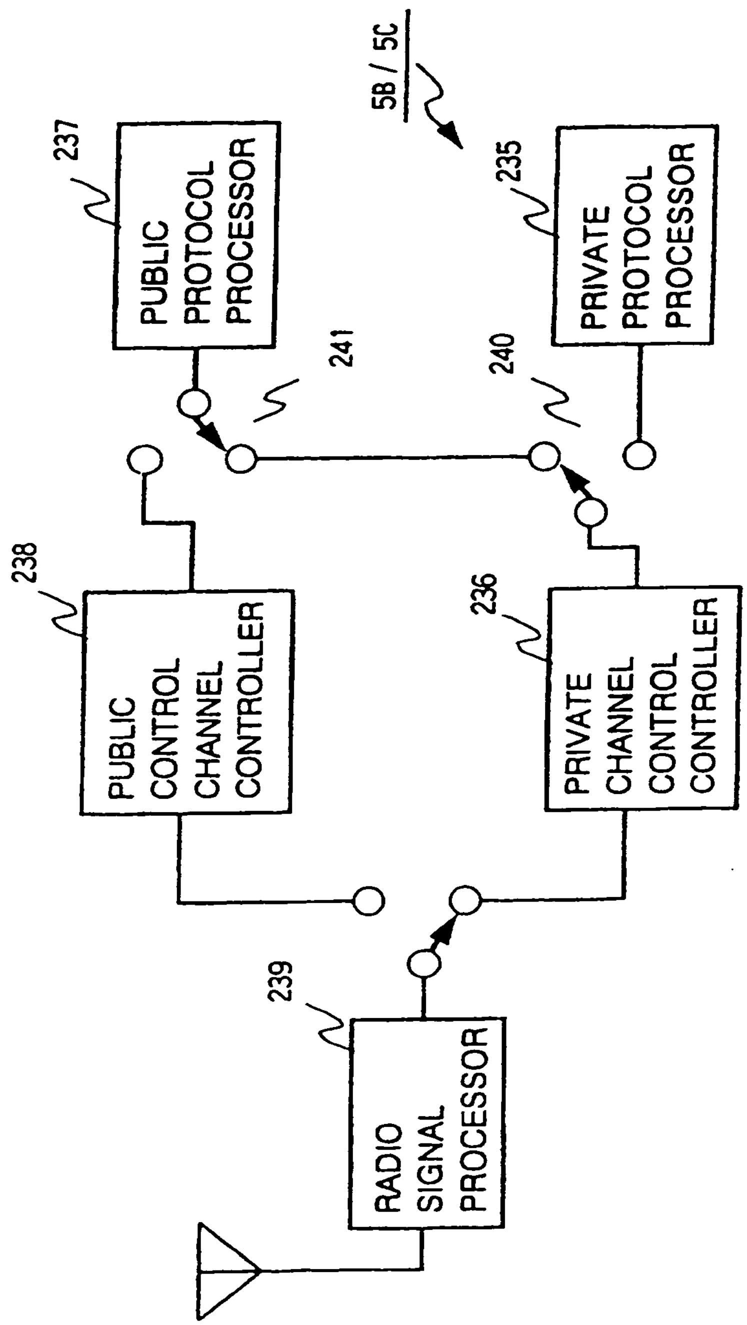

PUBLIC SWITCHED TELEPHONE NETWORK
1
PBX
3
RADIO BASE STATION
4A
4B
4C
4D
5A
5B
5C
PRIVATE SYSTEM
2

Fig.59


PUBLIC PROTOCOL PROCESSOR
237
5B / 5C
PRIVATE PROTOCOL PROCESSOR
235
241
240
PUBLIC CONTROL CHANNEL CONTROLLER
238
PRIVATE CHANNEL CONTROL CONTROLLER
236
RADIO SIGNAL PROCESSOR
239

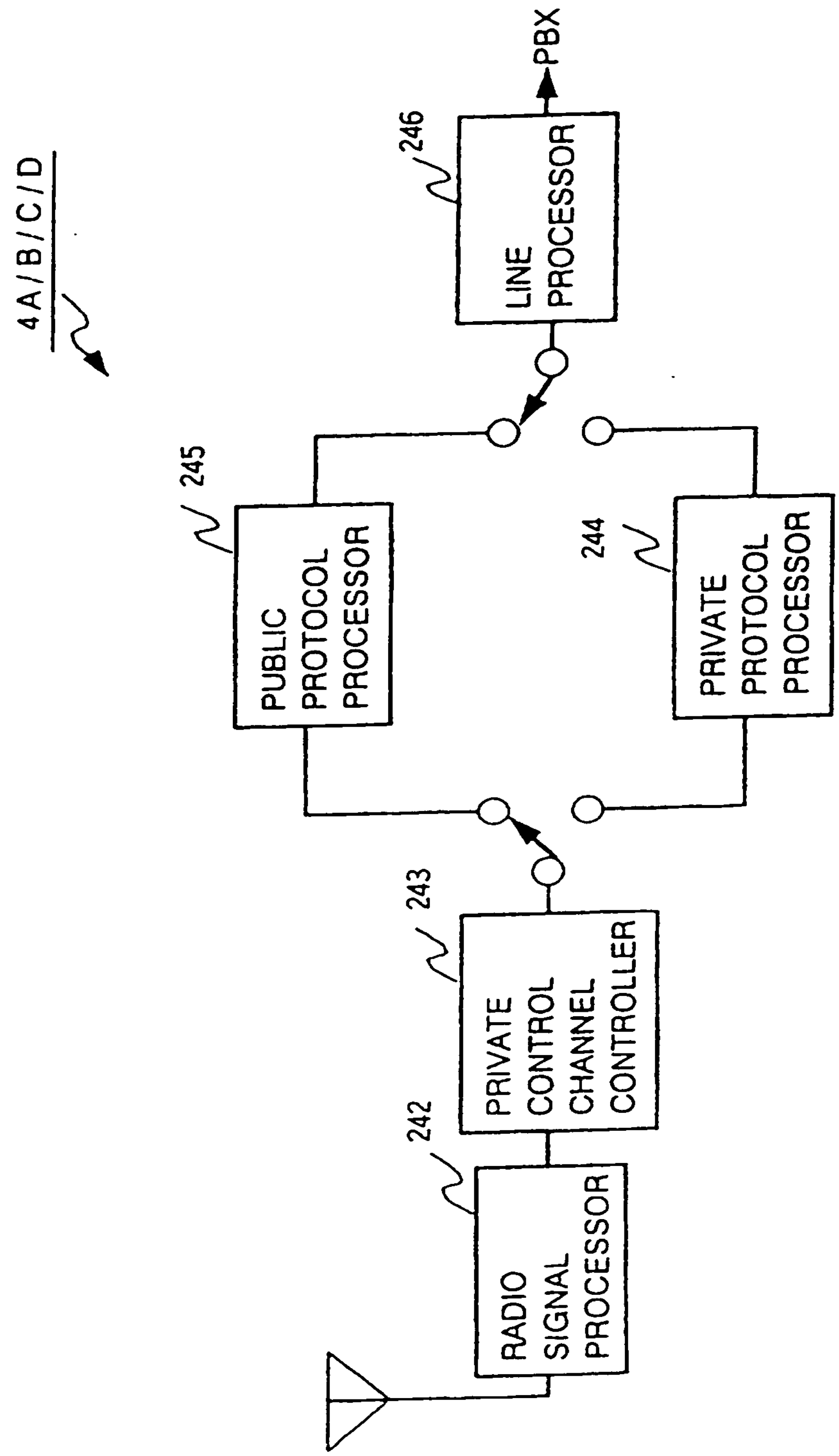

4A/B/C/D
PBX
246
LINE PROCESSOR
245
PUBLIC PROTOCOL PROCESSOR
244
PRIVATE PROTOCOL PROCESSOR
243
PRIVATE CONTROL CHANNEL CONTROLLER
242
RADIO SIGNAL PROCESSOR

Fig.60

Fig.61

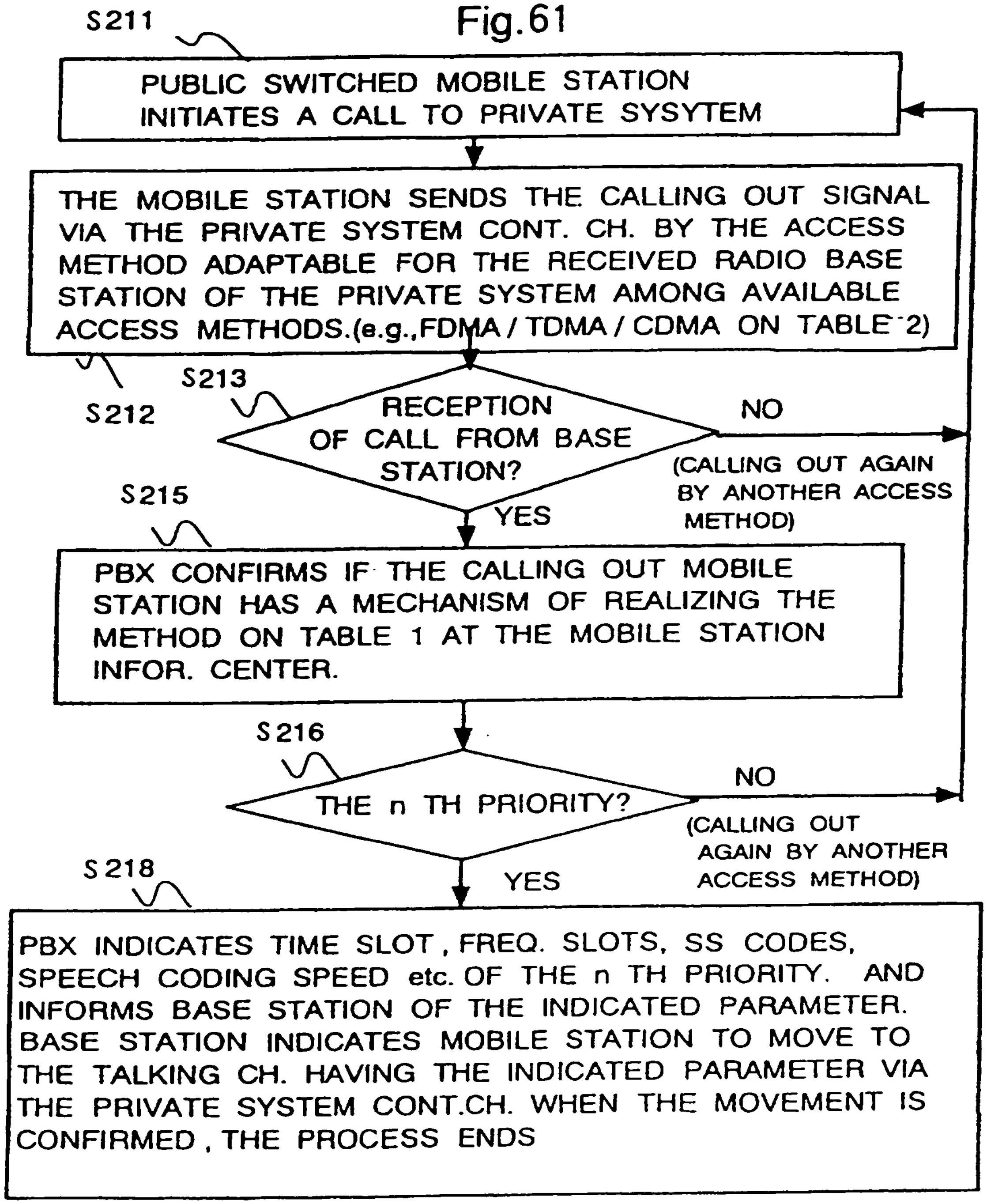

S211
PUBLIC SWITCHED MOBILE STATION INITIATES A CALL TO PRIVATE SYSYTEM
THE MOBILE STATION SENDS THE CALLING OUT SIGNAL VIA THE PRIVATE SYSTEM CONT. CH. BY THE ACCESS METHOD ADAPTABLE FOR THE RECEIVED RADIO BASE STATION OF THE PRIVATE SYSTEM AMONG AVAILABLE ACCESS METHODS.(e.g.,FDMA / TDMA / CDMA ON TABLE 2)
S212
S213
RECEPTION OF CALL FROM BASE STATION?
NO
(CALLING OUT AGAIN BY ANOTHER ACCESS METHOD)
YES
S215
PBX CONFIRMS IF THE CALLING OUT MOBILE STATION HAS A MECHANISM OF REALIZING THE METHOD ON TABLE 1 AT THE MOBILE STATION INFOR. CENTER.
S216
THE n TH PRIORITY?
NO
(CALLING OUT AGAIN BY ANOTHER ACCESS METHOD)
YES
S218
PBX INDICATES TIME SLOT, FREQ. SLOTS, SS CODES, SPEECH CODING SPEED etc. OF THE n TH PRIORITY. AND INFORMS BASE STATION OF THE INDICATED PARAMETER. BASE STATION INDICATES MOBILE STATION TO MOVE TO THE TALKING CH. HAVING THE INDICATED PARAMETER VIA THE PRIVATE SYSTEM CONT.CH. WHEN THE MOVEMENT IS CONFIRMED, THE PROCESS ENDS

Fig.62

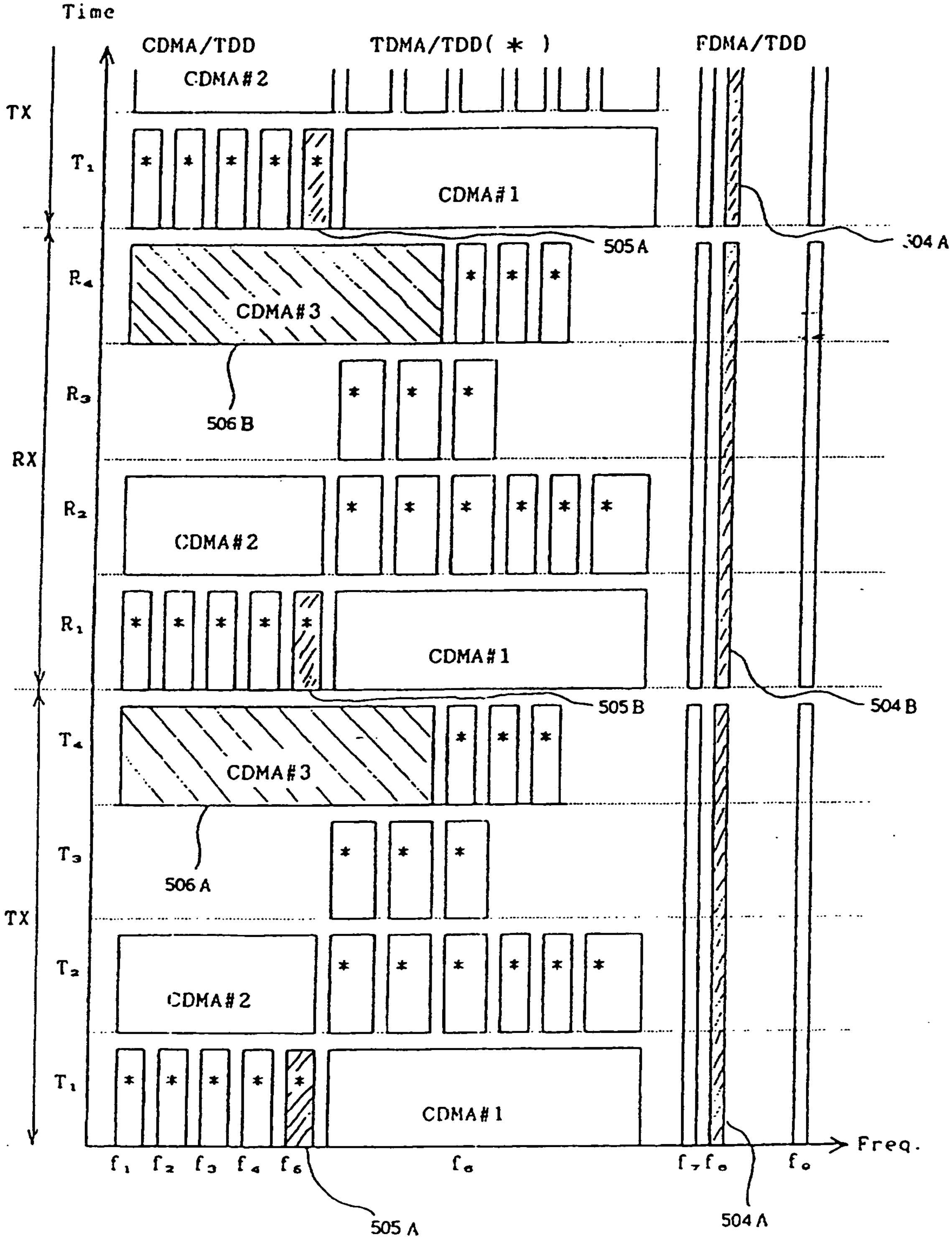

Time
CDMA/TDD
TDMA/TDD(*)
FDMA/TDD
CDMA#2
CDMA#1
CDMA#3
TX
RX
T₁
R₄
R₃
R₂
R₁
T₄
T₃
T₂
505 A
504 A
506 B
505 B
504 B
506 A
f₁ f₂ f₃ f₄ f₆
f₆
f₇ f₈
f₉
Freq.

Fig.63

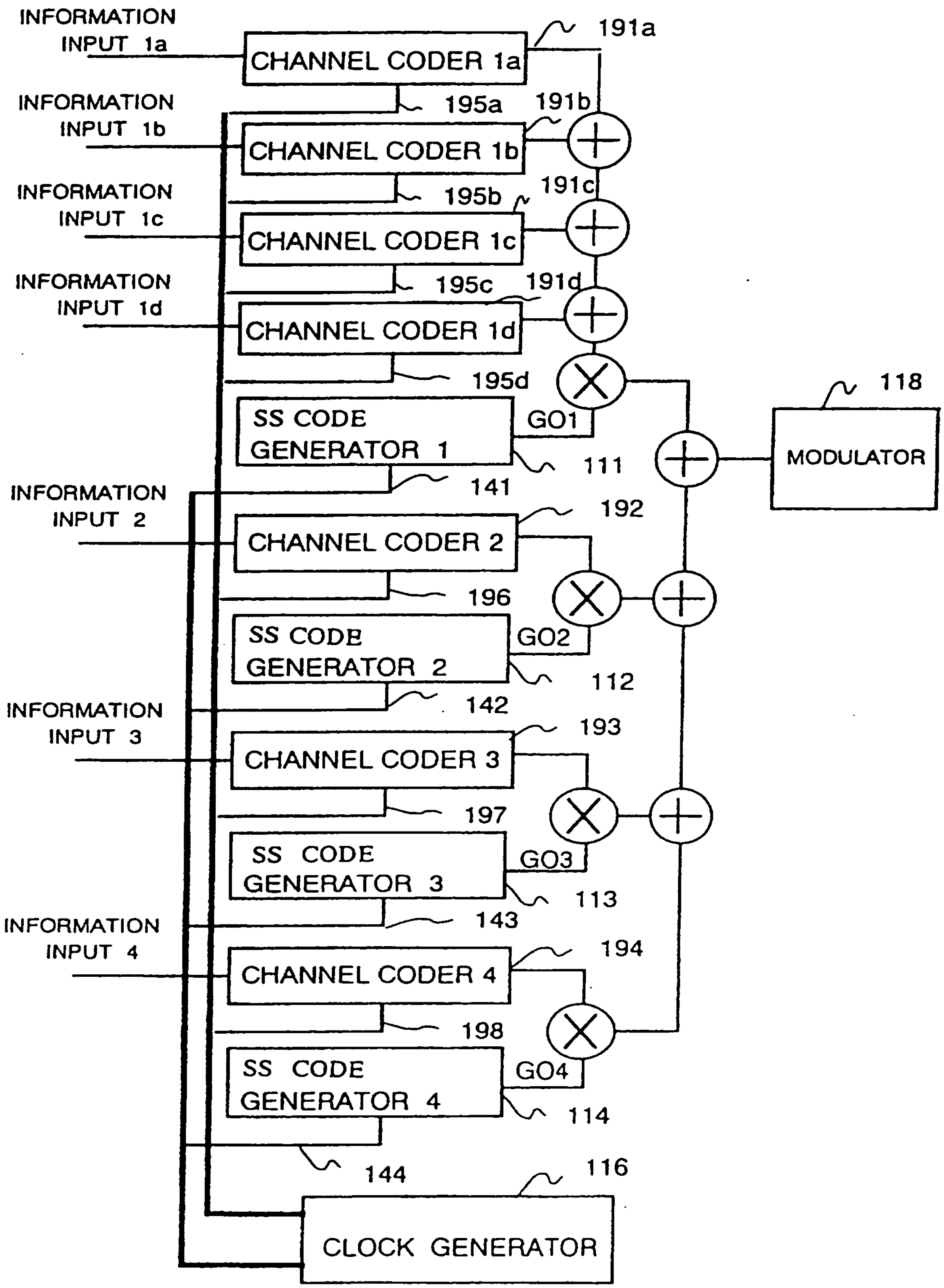

INFORMATION INPUT 1a
CHANNEL CODER 1a
191a
195a
191b
INFORMATION INPUT 1b
CHANNEL CODER 1b
195b
191c
INFORMATION INPUT 1c
CHANNEL CODER 1c
195c
191d
INFORMATION INPUT 1d
CHANNEL CODER 1d
195d
SS CODE GENERATOR 1
GO1
111
118
MODULATOR
141
INFORMATION INPUT 2
192
CHANNEL CODER 2
196
SS CODE GENERATOR 2
GO2
112
142
INFORMATION INPUT 3
193
CHANNEL CODER 3
197
SS CODE GENERATOR 3
GO3
113
143
INFORMATION INPUT 4
194
CHANNEL CODER 4
198
SS CODE GENERATOR 4
GO4
114
144
116
CLOCK GENERATOR

Fig.64

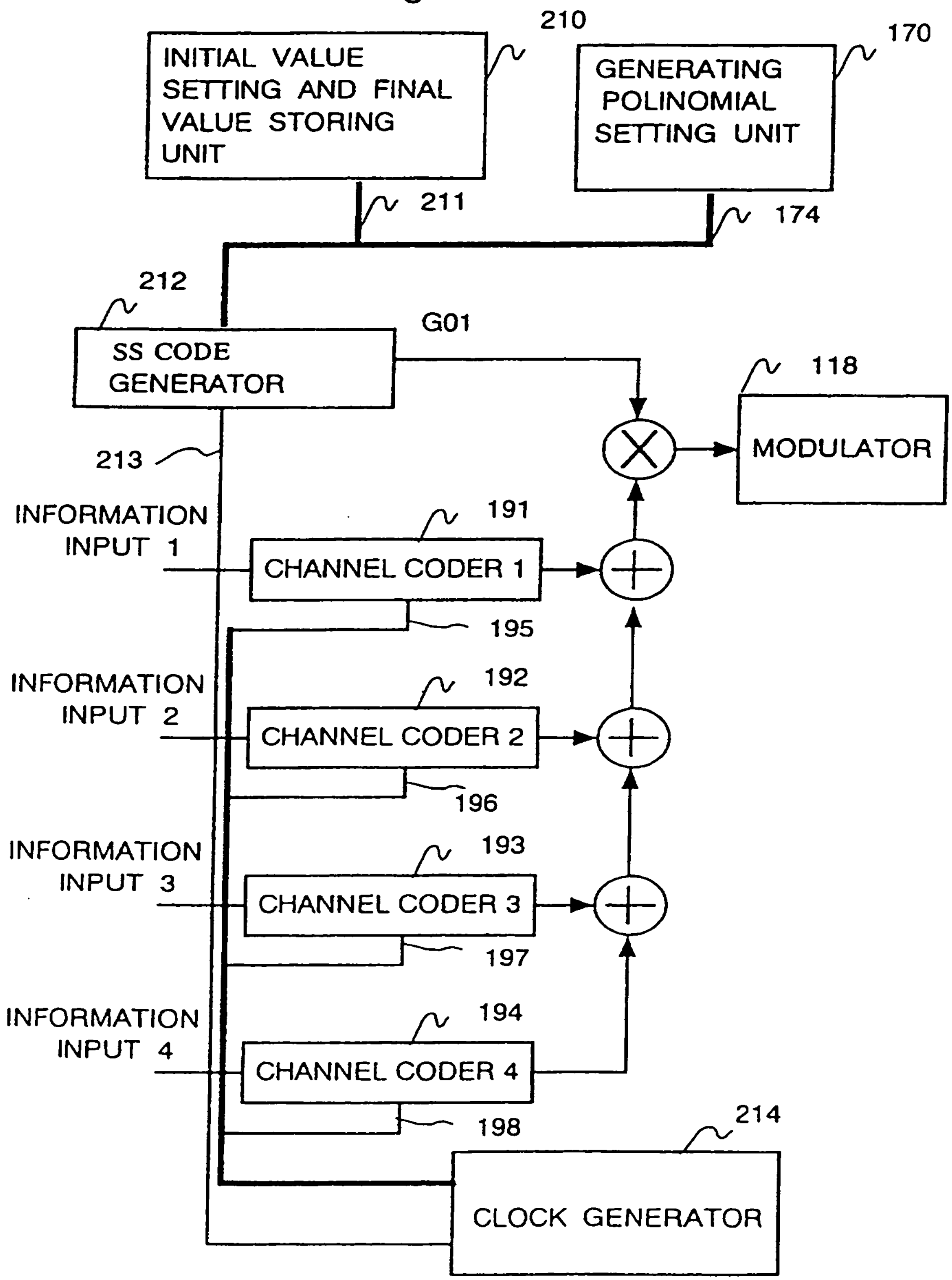

210
INITIAL VALUE SETTING AND FINAL VALUE STORING UNIT
170
GENERATING POLINOMIAL SETTING UNIT
211
174
212
SS CODE GENERATOR
G01
118
MODULATOR
213
INFORMATION INPUT 1
191
CHANNEL CODER 1
195
INFORMATION INPUT 2
192
CHANNEL CODER 2
196
INFORMATION INPUT 3
193
CHANNEL CODER 3
197
INFORMATION INPUT 4
194
CHANNEL CODER 4
198
214
CLOCK GENERATOR

Fig.65

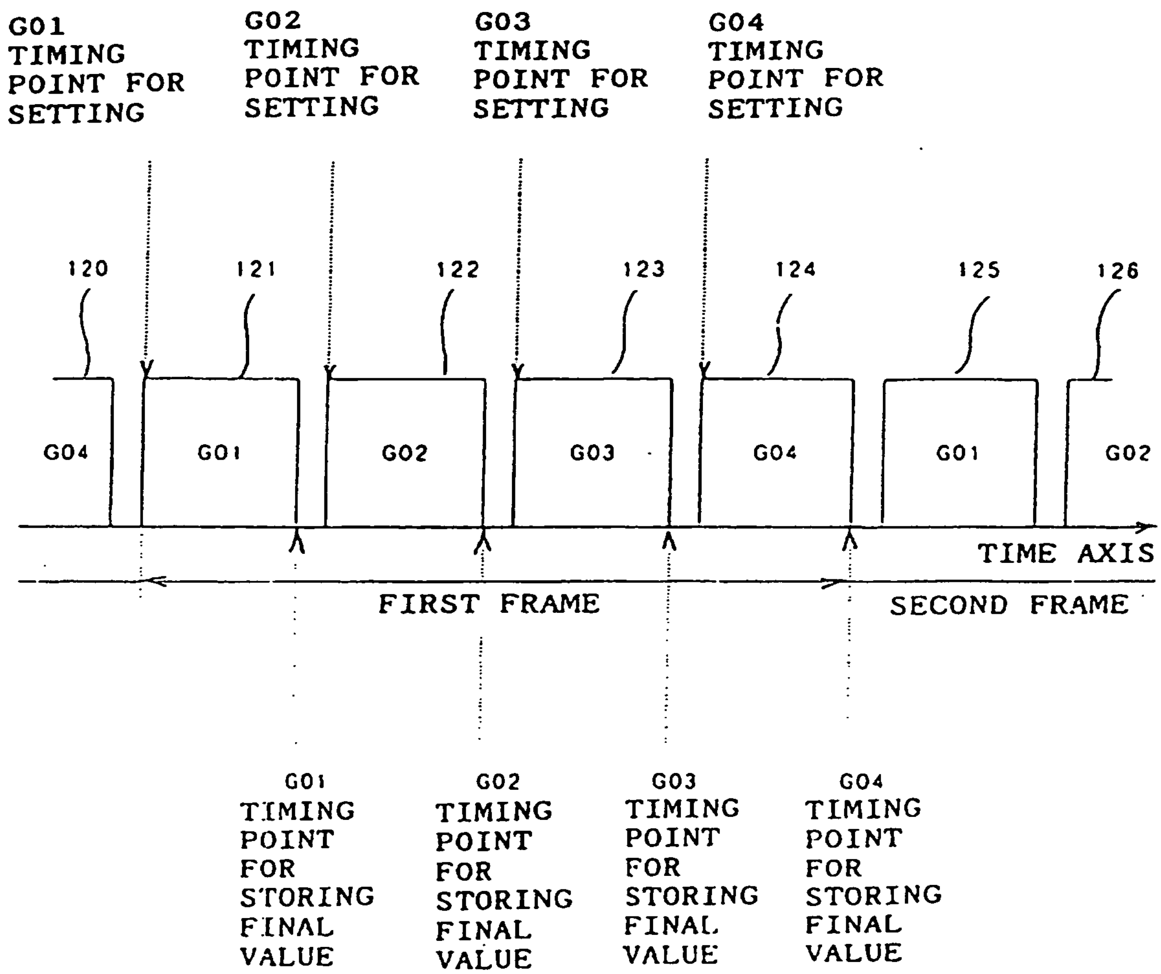

G01
TIMING
POINT FOR
SETTING
G02
TIMING
POINT FOR
SETTING
G03
TIMING
POINT FOR
SETTING
G04
TIMING
POINT FOR
SETTING
120
121
122
123
124
125
126
G04
G01
G02
G03
G04
G01
G02
TIME AXIS
FIRST FRAME
SECOND FRAME
G01
TIMING
POINT
FOR
STORING
FINAL
VALUE
G02
TIMING
POINT
FOR
STORING
FINAL
VALUE
G03
TIMING
POINT
FOR
STORING
FINAL
VALUE
G04
TIMING
POINT
FOR
STORING
FINAL
VALUE

Fig. 66

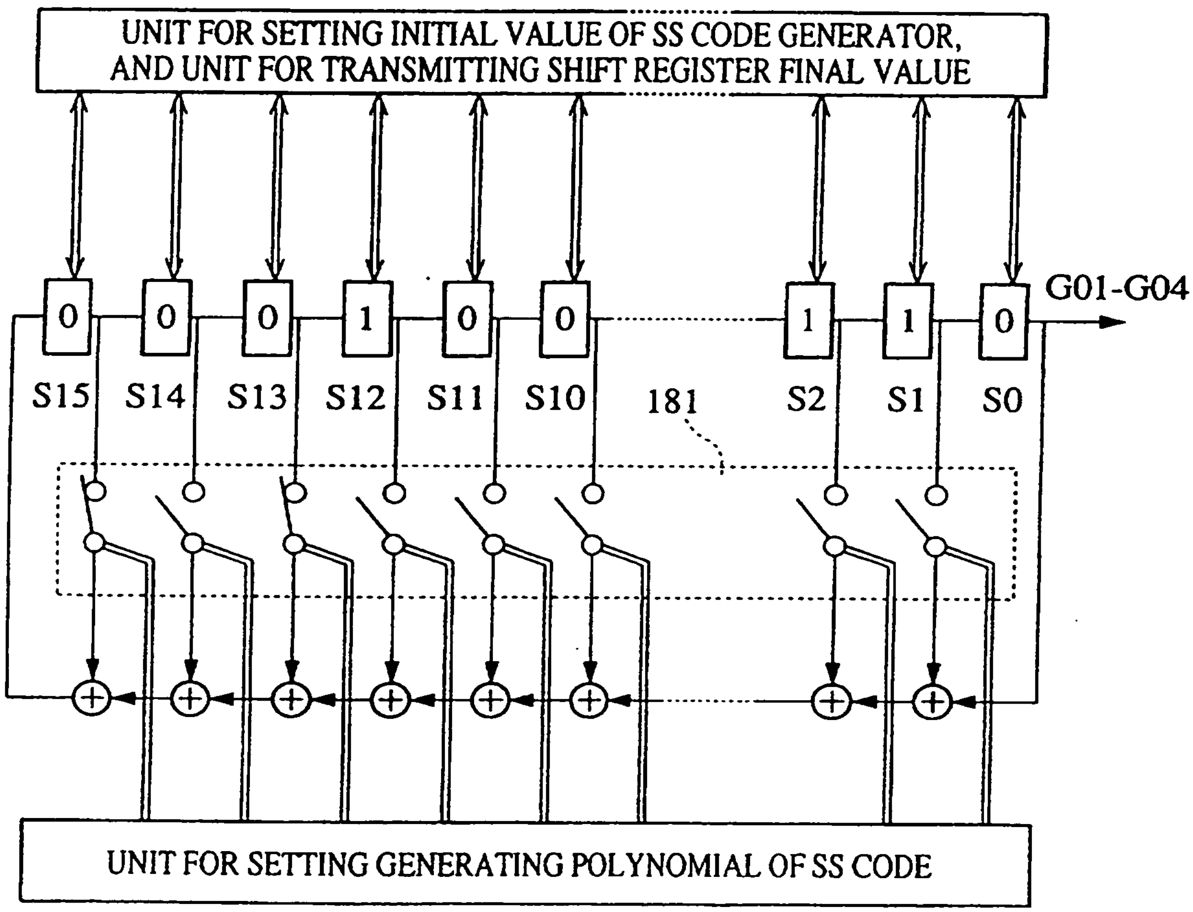

UNIT FOR SETTING INITIAL VALUE OF SS CODE GENERATOR, AND UNIT FOR TRANSMITTING SHIFT REGISTER FINAL VALUE
0
0
0
1
0
0
1
1
0
G01-G04
S15
S14
S13
S12
S11
S10
181
S2
S1
S0
UNIT FOR SETTING GENERATING POLYNOMIAL OF SS CODE

Fig. 67

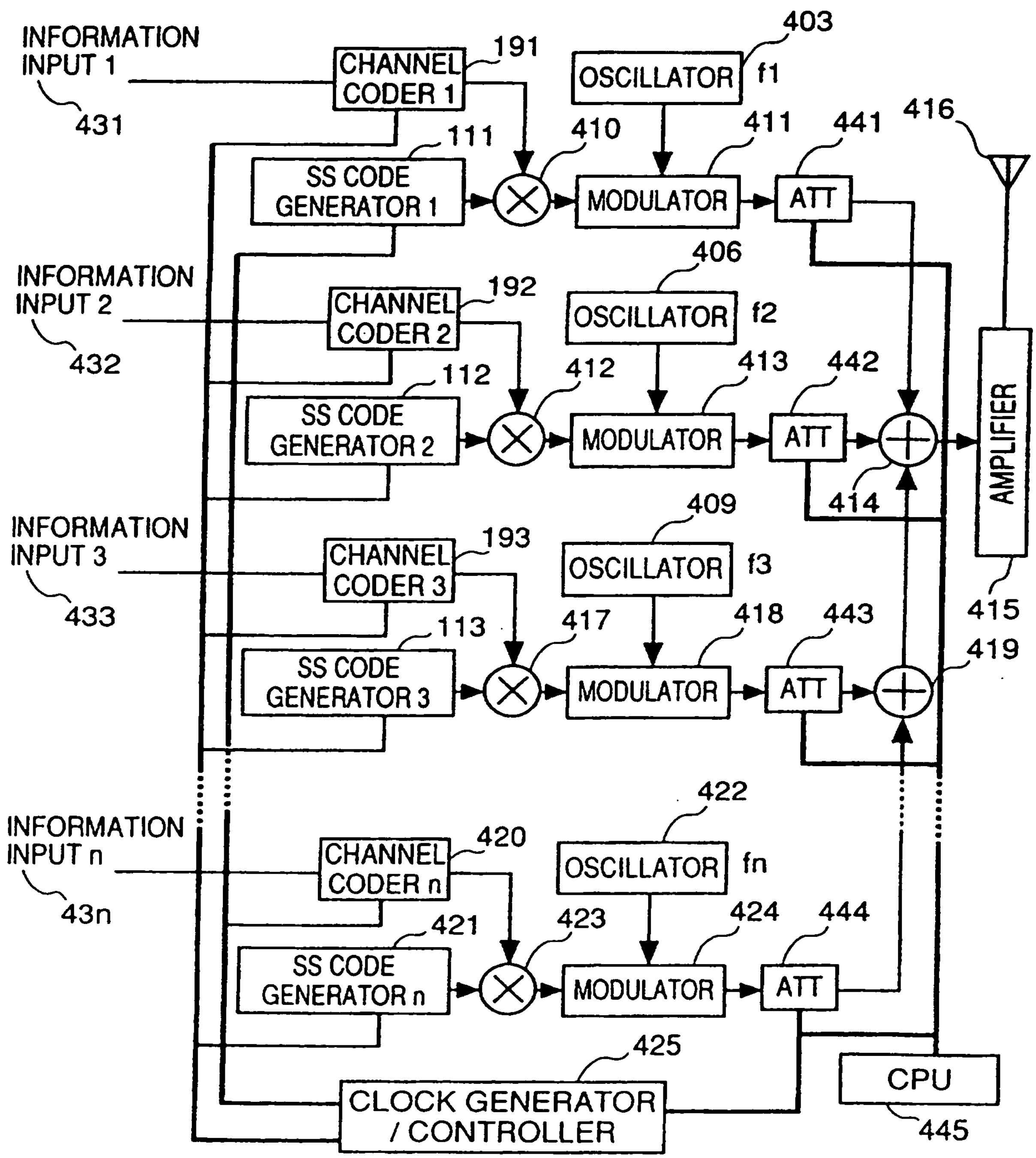

INFORMATION INPUT 1
431
CHANNEL CODER 1
191
OSCILLATOR
403
f1
SS CODE GENERATOR 1
111
410
MODULATOR
411
ATT
441
416
INFORMATION INPUT 2
432
CHANNEL CODER 2
192
OSCILLATOR
406
f2
SS CODE GENERATOR 2
112
412
MODULATOR
413
ATT
442
414
AMPLIFIER
415
INFORMATION INPUT 3
433
CHANNEL CODER 3
193
OSCILLATOR
409
f3
SS CODE GENERATOR 3
113
417
MODULATOR
418
ATT
443
419
INFORMATION INPUT n
43n
CHANNEL CODER n
420
OSCILLATOR
422
fn
SS CODE GENERATOR n
421
423
MODULATOR
424
ATT
444
CLOCK GENERATOR / CONTROLLER
425
CPU
445

Fig.68

	INFORMATION INPUT NO.	SLOT NO.	DATA RATE R_D (bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)	NO. OF SIMULTANEOUS TALKING CHS
THE NUMBER OF CHANNELS AT EACH TIME SLOT OF RADIO BASE STATION 6	1	1	384K	TDMA	0	1
	2 - 37	2	19.2K	CDMA	12.288M	36
	38	3	192K	TDMA	0	1
	39 - 52	4	9.6K	CDMA	6.144M	14

Fig. 69

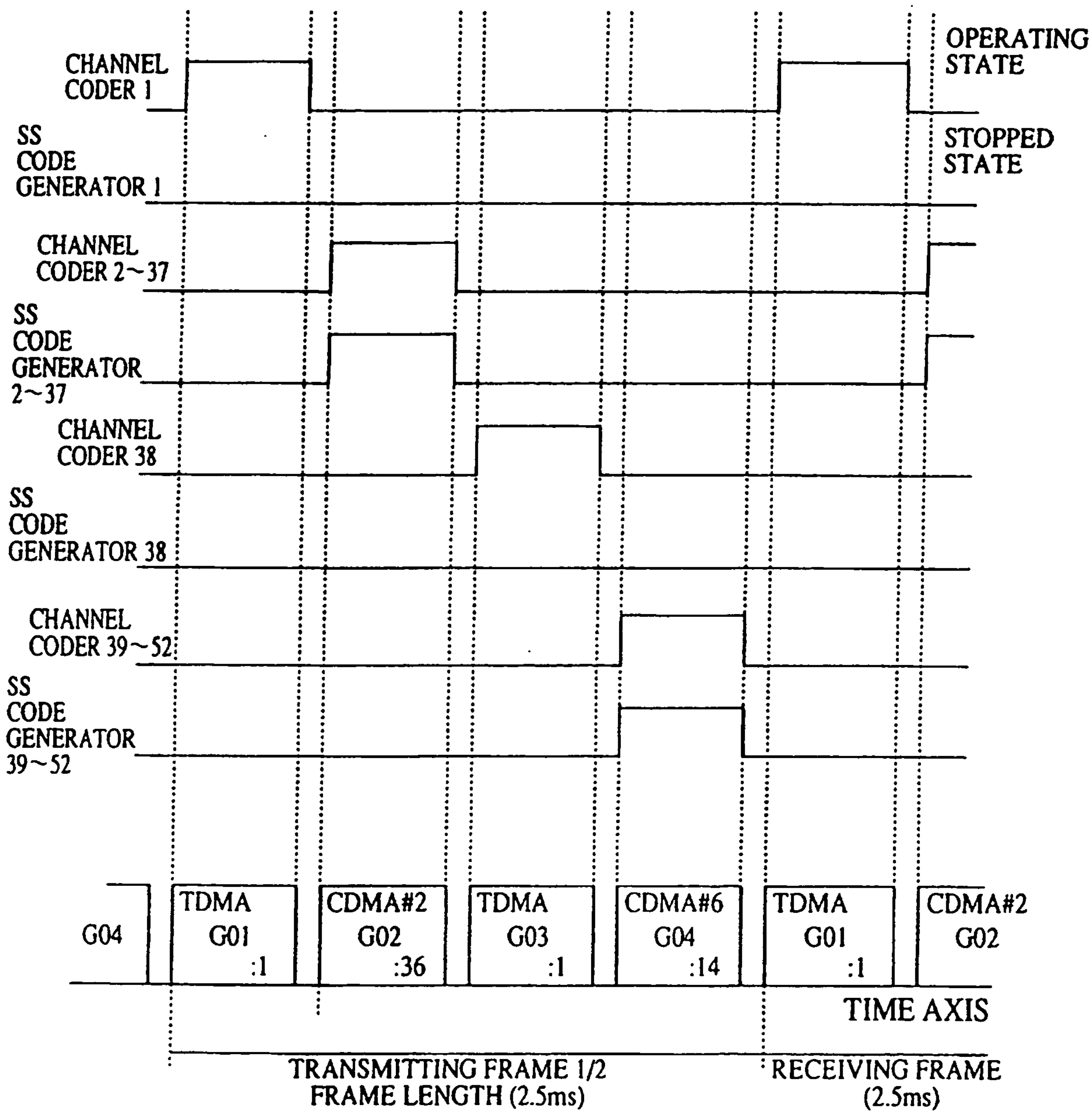

CHANNEL CODER 1
SS CODE GENERATOR 1
CHANNEL CODER 2~37
SS CODE GENERATOR 2~37
CHANNEL CODER 38
SS CODE GENERATOR 38
CHANNEL CODER 39~52
SS CODE GENERATOR 39~52
OPERATING STATE
STOPPED STATE
G04
TDMA G01 :1
CDMA#2 G02 :36
TDMA G03 :1
CDMA#6 G04 :14
TDMA G01 :1
CDMA#2 G02
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME (2.5ms)

Fig.70

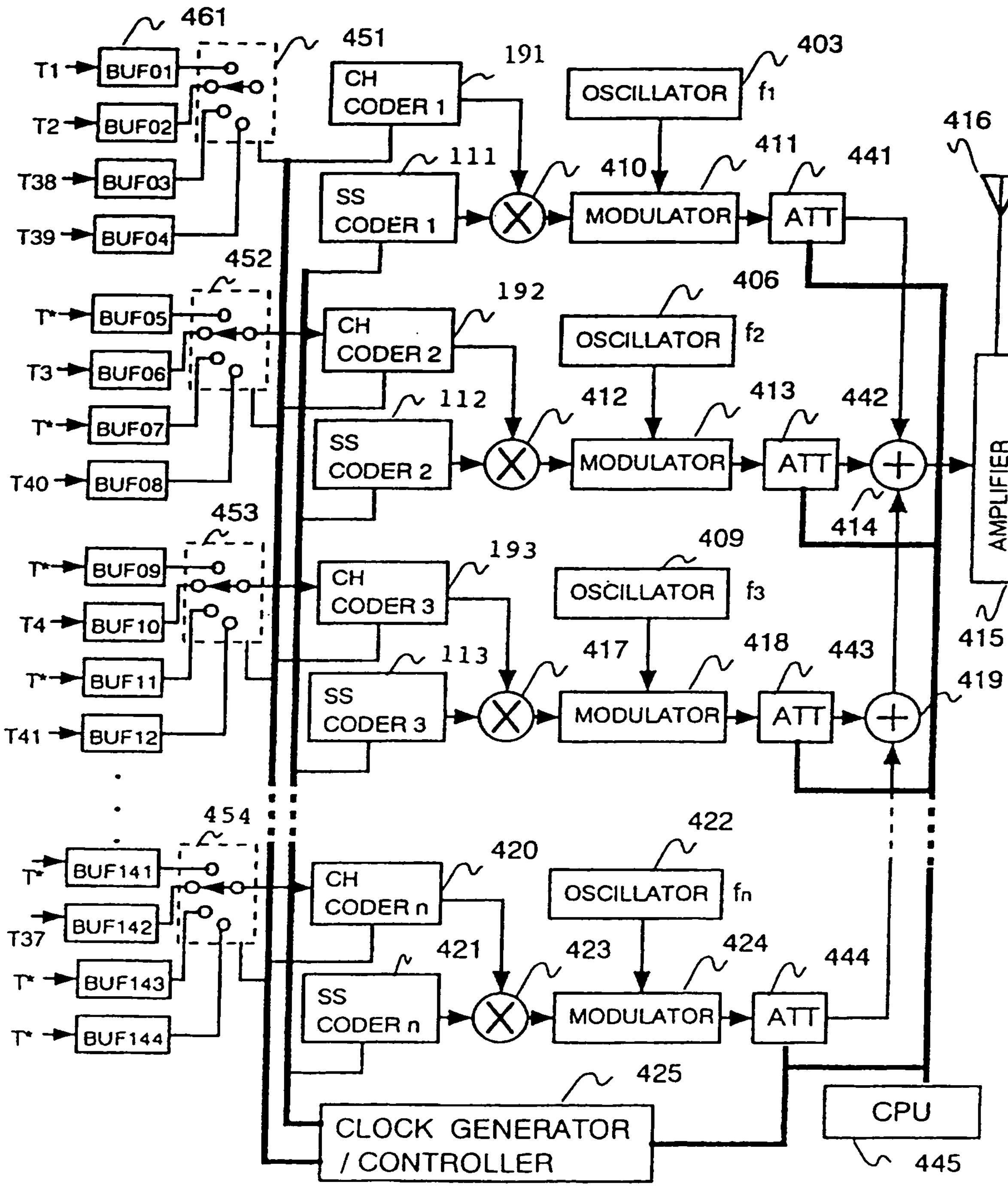

461
451
191
403
T1
BUF01
CH CODER 1
OSCILLATOR
f1
T2
BUF02
416
411
441
T38
BUF03
111
410
SS CODER 1
MODULATOR
ATT
T39
BUF04
452
406
192
T*
BUF05
CH CODER 2
OSCILLATOR
f2
T3
BUF06
112
412
413
442
T*
BUF07
SS CODER 2
MODULATOR
ATT
T40
BUF08
AMPLIFIER
414
453
409
193
T*
BUF09
CH CODER 3
OSCILLATOR
f3
T4
BUF10
415
113
417
418
443
T*
BUF11
419
SS CODER 3
MODULATOR
ATT
T41
BUF12
454
422
420
T*
BUF141
CH CODER n
OSCILLATOR
fn
T37
BUF142
421
423
424
444
T*
BUF143
SS CODER n
MODULATOR
ATT
T*
BUF144
425
CPU
CLOCK GENERATOR / CONTROLLER
445

Fig.71 A

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D(bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)
1	1	1	1	384k	TDMA	0
2	2		2	19.2k	CDMA	12.288M
38	3		3	192k	TDMA	0
39	4		4	9.6K	CDMA	6.144M
3	6	2	2	19.2k	CDMA	12.288M
40	8		4	9.6K	CDMA	6.144M
4	10	3	2	19.2k	CDMA	12.288M
41	12		4	9.6K	CDMA	6.144M
5	14	4	2	19.2k	CDMA	12.288M
42	16		4	9.6K	CDMA	6.144M
6	18	5	2	19.2k	CDMA	12.288M
43	20		4	9.6K	CDMA	6.144M
7	22	6	2	19.2k	CDMA	12.288M
44	24		4	9.6K	CDMA	6.144M
8	26	7	2	19.2k	CDMA	12.288M
45	28		4	9.6K	CDMA	6.144M
9	30	8	2	19.2k	CDMA	12.288M
46	32		4	9.6K	CDMA	6.144M
10	34	9	2	19.2k	CDMA	12.288M
47	36		4	9.6K	CDMA	6.144M
11	38	10	2	19.2k	CDMA	12.288M
48	40		4	9.6K	CDMA	6.144M
12	42	11	2	19.2k	CDMA	12.288M
49	44		4	9.6K	CDMA	6.144M
13	46	12	2	19.2k	CDMA	12.288M
50	48		4	9.6K	CDMA	6.144M
14	50	13	2	19.2k	CDMA	12.288M
51	52		4	9.6K	CDMA	6.144M
15	54	14	2	19.2k	CDMA	12.288M
52	56		4	9.6K	CDMA	6.144M

Fig.71 B

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D(bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)
16	58	15	2	19.2k	CDMA	12.288M
17	62	16	2	19.2k	CDMA	12.288M
18	66	17	2	19.2k	CDMA	12.288M
19	70	18	2	19.2k	CDMA	12.288M
20	74	19	2	19.2k	CDMA	12.288M
21	78	20	2	19.2k	CDMA	12.288M
22	82	21	2	19.2k	CDMA	12.288M
23	86	22	2	19.2k	CDMA	12.288M
24	90	23	2	19.2k	CDMA	12.288M
25	94	24	2	19.2k	CDMA	12.288M
26	98	25	2	19.2k	CDMA	12.288M
27	102	26	2	19.2k	CDMA	12.288M
28	106	27	2	19.2k	CDMA	12.288M
29	110	28	2	19.2k	CDMA	12.288M
30	114	29	2	19.2k	CDMA	12.288M
31	118	30	2	19.2k	CDMA	12.288M
32	122	31	2	19.2k	CDMA	12.288M
33	126	32	2	19.2k	CDMA	12.288M
34	130	33	2	19.2k	CDMA	12.288M
35	134	34	2	19.2k	CDMA	12.288M
36	138	35	2	19.2k	CDMA	12.288M
37	142	36	2	19.2k	CDMA	12.288M

Fig. 72

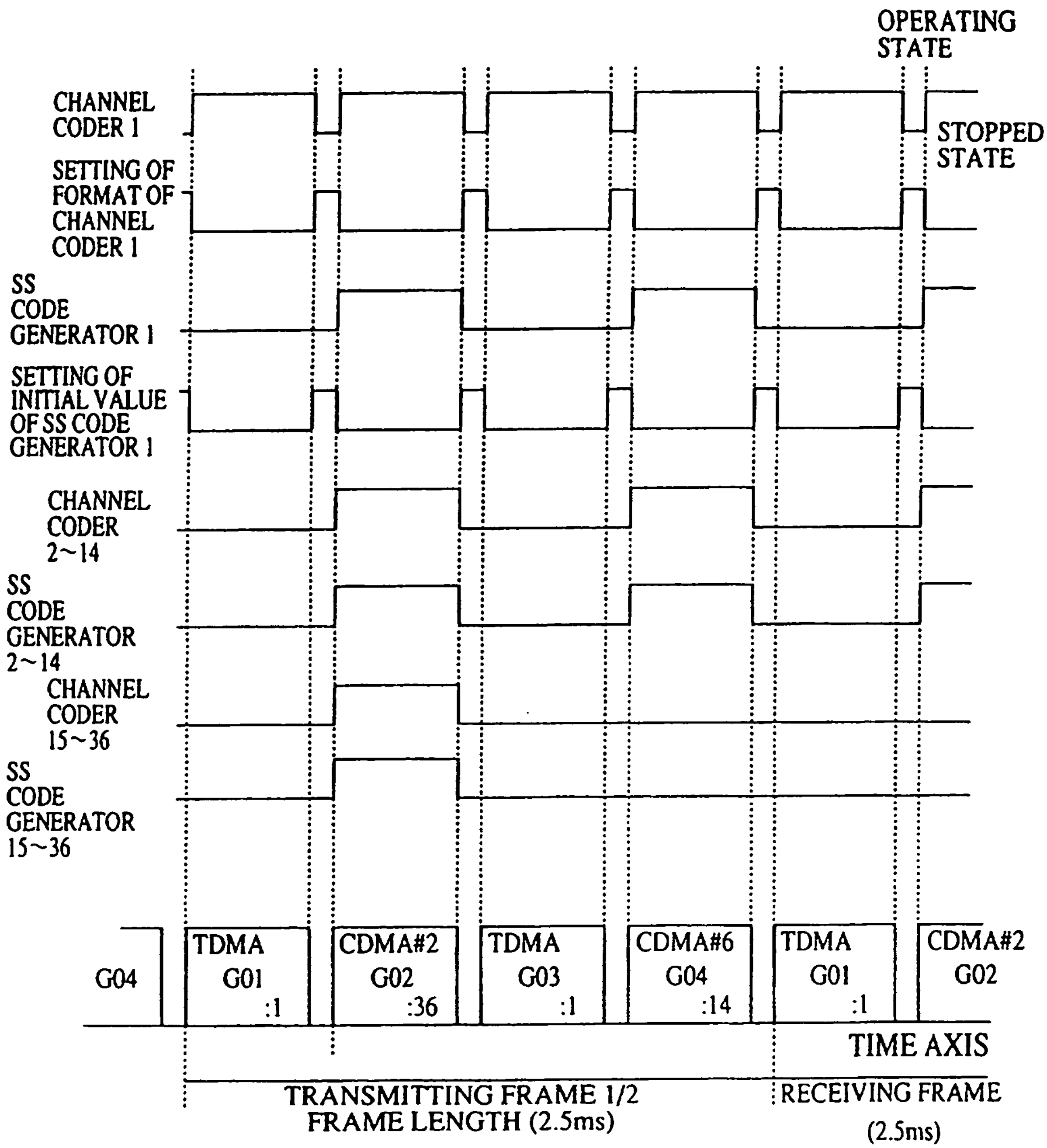

OPERATING STATE
CHANNEL CODER 1
STOPPED STATE
SETTING OF FORMAT OF CHANNEL CODER 1
SS CODE GENERATOR 1
SETTING OF INITIAL VALUE OF SS CODE GENERATOR 1
CHANNEL CODER 2~14
SS CODE GENERATOR 2~14
CHANNEL CODER 15~36
SS CODE GENERATOR 15~36
G04
TDMA G01 :1
CDMA#2 G02 :36
TDMA G03 :1
CDMA#6 G04 :14
TDMA G01 :1
CDMA#2 G02
TIME AXIS
TRANSMITTING FRAME 1/2
FRAME LENGTH (2.5ms)
RECEIVING FRAME
(2.5ms)

Fig.73

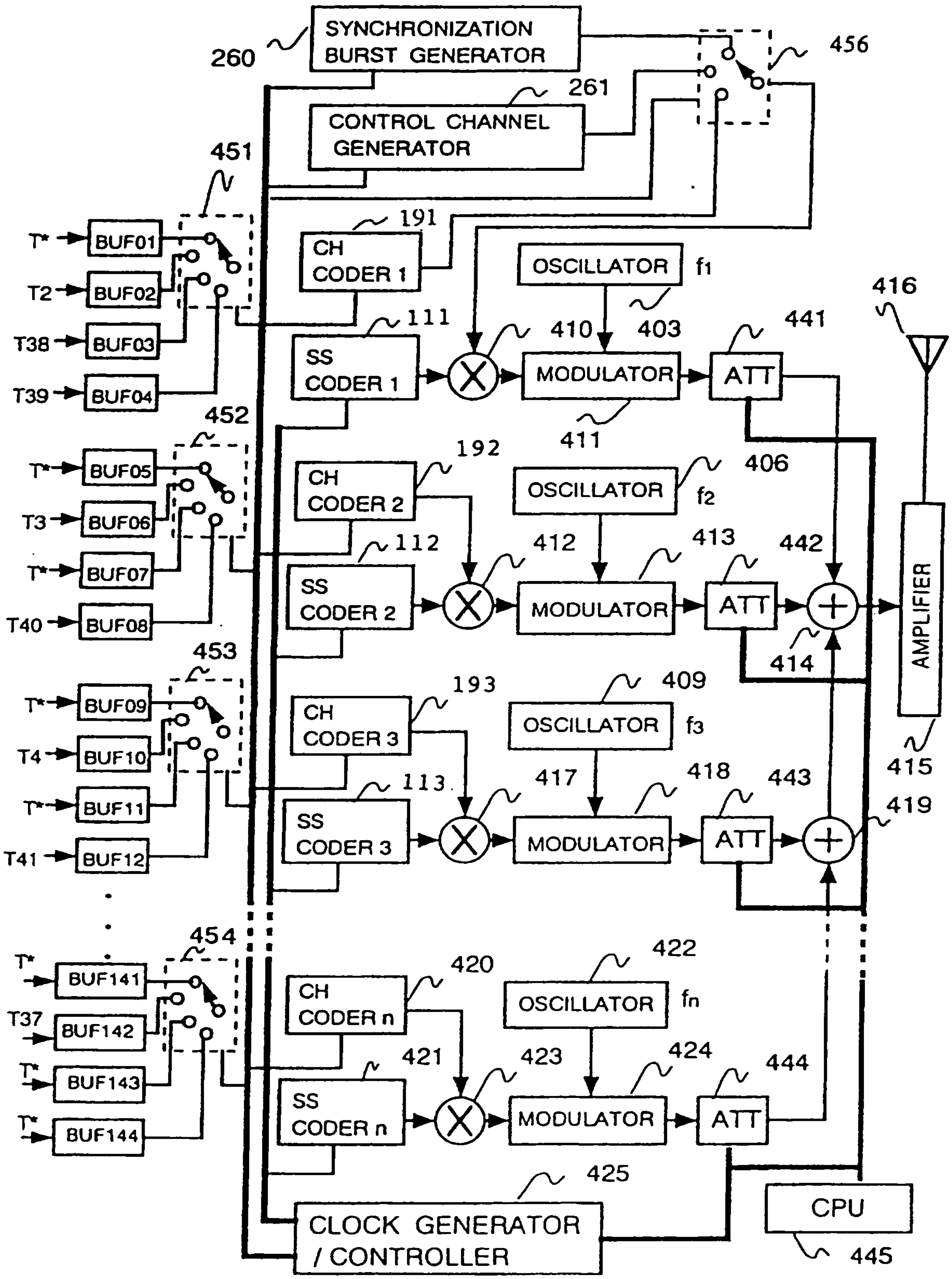

SYNCHRONIZATION BURST GENERATOR
260
456
CONTROL CHANNEL GENERATOR
261
451
T*
T2
T38
T39
BUF01
BUF02
BUF03
BUF04
CH CODER 1
191
SS CODER 1
111
OSCILLATOR
f1
410
403
MODULATOR
411
ATT
441
416
452
T*
T3
T*
T40
BUF05
BUF06
BUF07
BUF08
CH CODER 2
192
SS CODER 2
112
OSCILLATOR
f2
406
412
413
MODULATOR
ATT
442
414
AMPLIFIER
453
T*
T4
T*
T41
BUF09
BUF10
BUF11
BUF12
CH CODER 3
193
SS CODER 3
113
OSCILLATOR
f3
409
417
418
MODULATOR
ATT
443
419
415
454
T*
T37
T*
T*
BUF141
BUF142
BUF143
BUF144
CH CODER n
420
SS CODER n
421
OSCILLATOR
fn
422
423
424
MODULATOR
ATT
444
CLOCK GENERATOR / CONTROLLER
425
CPU
445

Fig.74 A

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D(bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)
SYNC.CONT.	1	1	1	9.6k	TDMA	0
2	2		2	19.2k	CDMA	12.288M
38	3		3	192k	TDMA	0
39	4		4	9.6K	CDMA	6.144M
3	6	2	2	19.2k	CDMA	12.288M
40	8		4	9.6K	CDMA	6.144M
4	10	3	2	19.2k	CDMA	12.288M
41	12		4	9.6K	CDMA	6.144M
5	14	4	2	19.2k	CDMA	12.288M
42	16		4	9.6K	CDMA	6.144M
6	18	5	2	19.2k	CDMA	12.288M
43	20		4	9.6K	CDMA	6.144M
7	22	6	2	19.2k	CDMA	12.288M
44	24		4	9.6K	CDMA	6.144M
8	26	7	2	19.2k	CDMA	12.288M
45	28		4	9.6K	CDMA	6.144M
9	30	8	2	19.2k	CDMA	12.288M
46	32		4	9.6K	CDMA	6.144M
10	34	9	2	19.2k	CDMA	12.288M
47	36		4	9.6K	CDMA	6.144M
11	38	10	2	19.2k	CDMA	12.288M
48	40		4	9.6K	CDMA	6.144M
12	42	11	2	19.2k	CDMA	12.288M
49	44		4	9.6K	CDMA	6.144M
13	46	12	2	19.2k	CDMA	12.288M
50	48		4	9.6K	CDMA	6.144M
14	50	13	2	19.2k	CDMA	12.288M
51	52		4	9.6K	CDMA	6.144M
15	54	14	2	19.2k	CDMA	12.288M
52	56		4	9.6K	CDMA	6.144M

Fig.74 B

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D(bps)	TX TYPE	CHIP RATE $1/t_{SP}$(cps)
16	58	15	2	19.2k	CDMA	12.288M
17	62	16	2	19.2k	CDMA	12.288M
18	66	17	2	19.2k	CDMA	12.288M
19	70	18	2	19.2k	CDMA	12.288M
20	74	19	2	19.2k	CDMA	12.288M
21	78	20	2	19.2k	CDMA	12.288M
22	82	21	2	19.2k	CDMA	12.288M
23	86	22	2	19.2k	CDMA	12.288M
24	90	23	2	19.2k	CDMA	12.288M
25	94	24	2	19.2k	CDMA	12.288M
26	98	25	2	19.2k	CDMA	12.288M
27	102	26	2	19.2k	CDMA	12.288M
28	106	27	2	19.2k	CDMA	12.288M
29	110	28	2	19.2k	CDMA	12.288M
30	114	29	2	19.2k	CDMA	12.288M
31	118	30	2	19.2k	CDMA	12.288M
32	122	31	2	19.2k	CDMA	12.288M
33	126	32	2	19.2k	CDMA	12.288M
34	130	33	2	19.2k	CDMA	12.288M
35	134	34	2	19.2k	CDMA	12.288M
36	138	35	2	19.2k	CDMA	12.288M
37	142	36	2	19.2k	CDMA	12.288M

Fig. 75

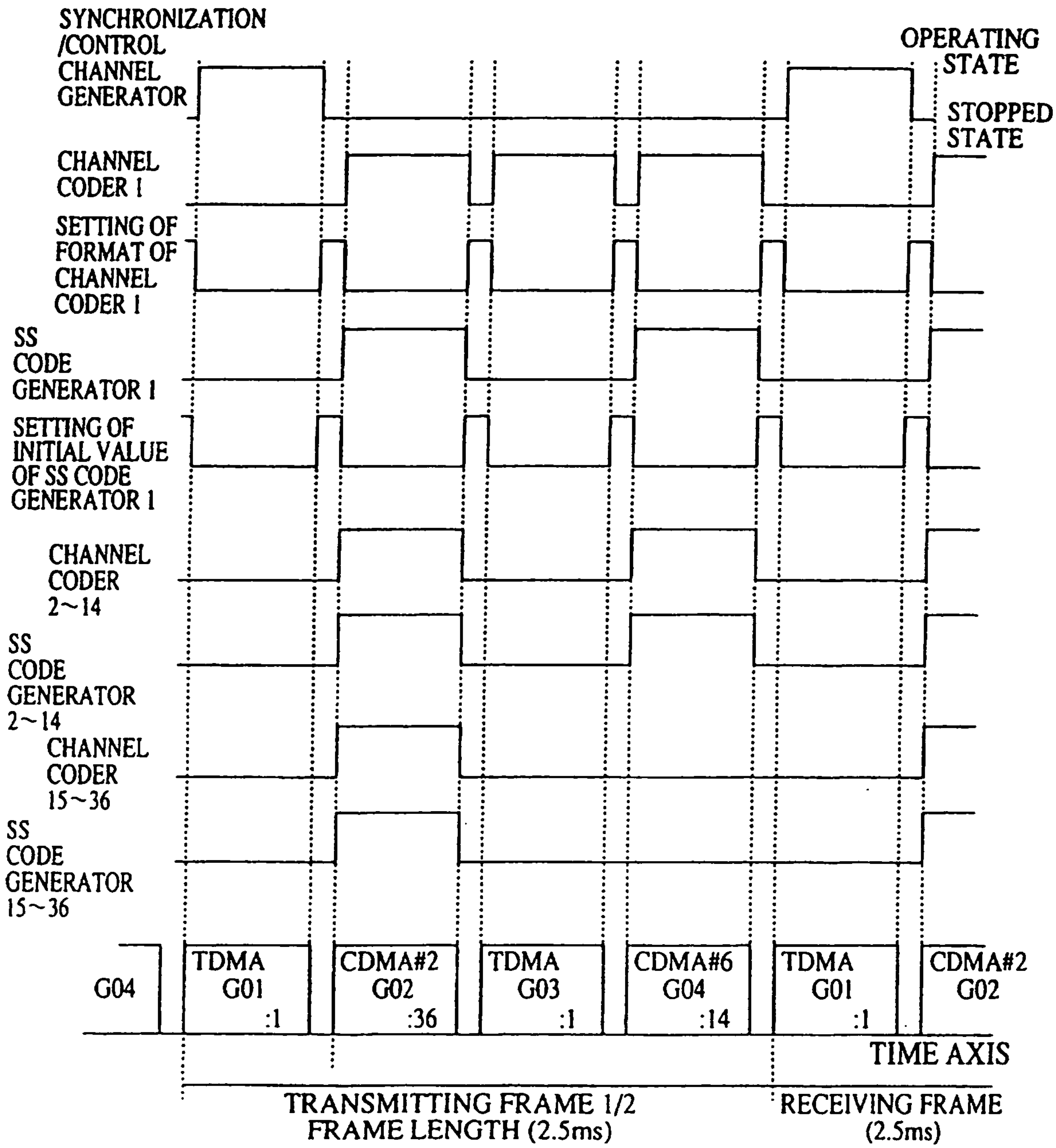

SYNCHRONIZATION /CONTROL CHANNEL GENERATOR
OPERATING STATE
STOPPED STATE
CHANNEL CODER 1
SETTING OF FORMAT OF CHANNEL CODER 1
SS CODE GENERATOR 1
SETTING OF INITIAL VALUE OF SS CODE GENERATOR 1
CHANNEL CODER 2~14
SS CODE GENERATOR 2~14
CHANNEL CODER 15~36
SS CODE GENERATOR 15~36
G04
TDMA G01 :1
CDMA#2 G02 :36
TDMA G03 :1
CDMA#6 G04 :14
TDMA G01 :1
CDMA#2 G02
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME (2.5ms)

Fig. 76

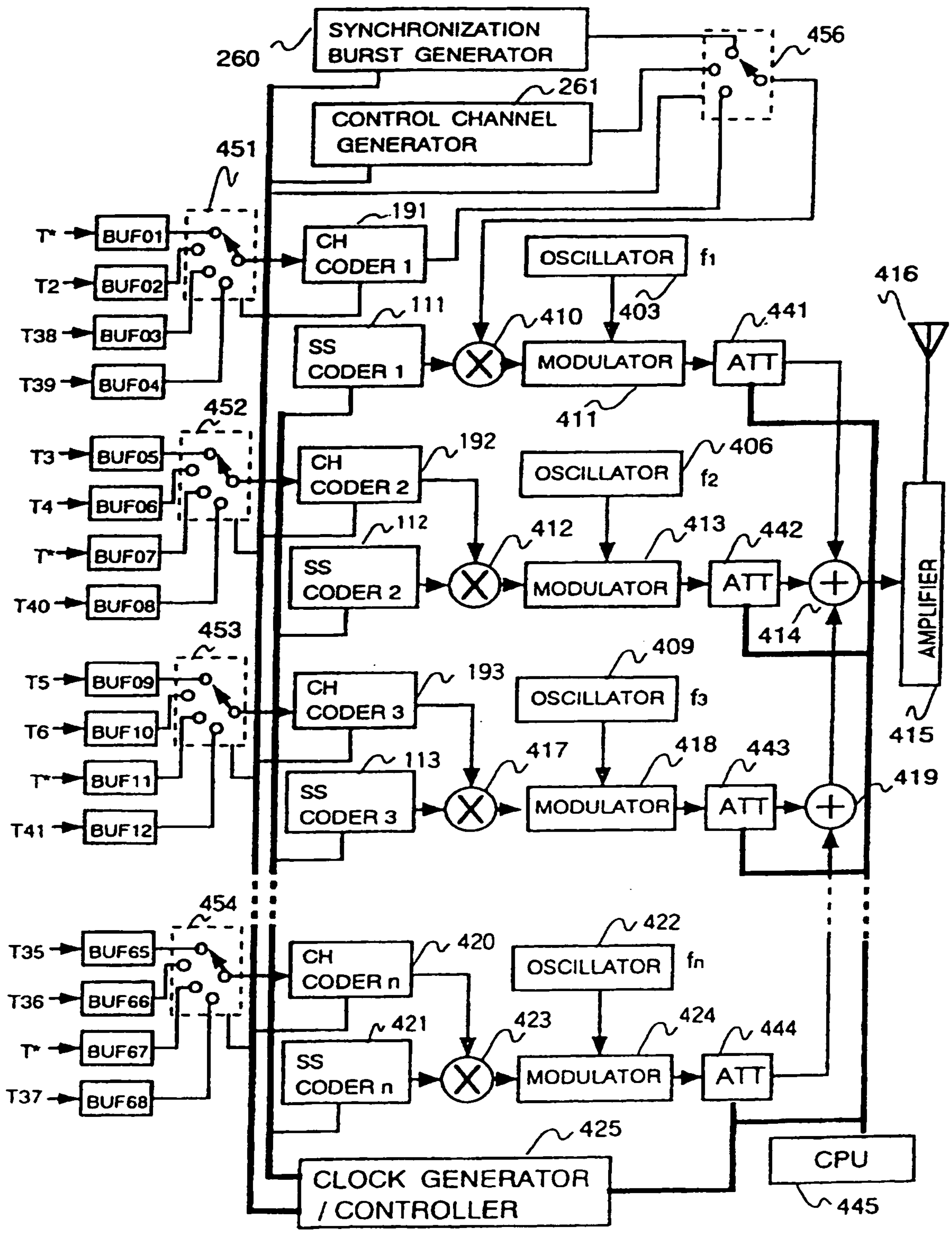

SYNCHRONIZATION BURST GENERATOR
260
456
CONTROL CHANNEL GENERATOR
261
451
T*
BUF01
T2
BUF02
T38
BUF03
T39
BUF04
CH CODER 1
191
SS CODER 1
111
OSCILLATOR
f1
403
410
MODULATOR
411
ATT
441
416
452
T3
BUF05
T4
BUF06
T*
BUF07
T40
BUF08
CH CODER 2
192
SS CODER 2
112
OSCILLATOR
406
f2
412
MODULATOR
413
ATT
442
414
AMPLIFIER
453
T5
BUF09
T6
BUF10
T*
BUF11
T41
BUF12
CH CODER 3
193
SS CODER 3
113
OSCILLATOR
409
f3
417
MODULATOR
418
ATT
443
419
415
454
T35
BUF65
T36
BUF66
T*
BUF67
T37
BUF68
CH CODER n
420
SS CODER n
421
OSCILLATOR
422
fn
423
MODULATOR
424
ATT
444
CLOCK GENERATOR / CONTROLLER
425
CPU
445

Fig. 77A

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D (bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)
SYNC.CONT.	1	1	1	9.6k	CDMA	6.144M
2	2		2	19.2k	CDMA	12.288M
38	3		3	192k	TDMA	0
39	4		4	9.6K	CDMA	6.144M
3	5	2	1	19.2k	CDMA	12.288M
4	6		2	19.2k	CDMA	12.288M
40	8		4	9.6K	CDMA	6.144M
5	9	3	1	19.2k	CDMA	12.288M
6	10		2	19.2k	CDMA	12.288M
41	12		4	9.6K	CDMA	6.144M
7	13	4	1	19.2k	CDMA	12.288M
8	14		2	19.2k	CDMA	12.288M
42	16		4	9.6K	CDMA	6.144M
9	17	5	1	19.2k	CDMA	12.288M
10	18		2	19.2k	CDMA	12.288M
43	20		4	9.6K	CDMA	6.144M
11	21	6	1	19.2k	CDMA	12.288M
12	22		2	19.2k	CDMA	12.288M
44	24		4	9.6K	CDMA	6.144M
13	25	7	1	19.2k	CDMA	12.288M
14	26		2	19.2k	CDMA	12.288M
45	28		4	9.6K	CDMA	6.144M
15	29	8	1	19.2k	CDMA	12.288M
16	30		2	19.2k	CDMA	12.288M
46	32		4	9.6K	CDMA	6.144M
17	33	9	1	19.2k	CDMA	12.288M
18	34		2	19.2k	CDMA	12.288M
47	36		4	9.6K	CDMA	6.144M
19	37	10	1	19.2k	CDMA	12.288M
20	38		2	19.2k	CDMA	12.288M
48	40		4	9.6K	CDMA	6.144M

Fig.77 B

INFO. INPUT NO.	BUFF NO.	CH/SS CORDER NO.	SLOT NO.	DATA RATE R_D (bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)
21	41	11	1	19.2k	CDMA	12.288M
22	42		2	19.2k	CDMA	12.288M
49	44		4	9.6K	CDMA	6.144M
23	45	12	1	19.2k	CDMA	12.288M
24	46		2	19.2k	CDMA	12.288M
50	48		4	9.6K	CDMA	6.144M
25	49	13	1	19.2k	CDMA	12.288M
26	50		2	19.2k	CDMA	12.288M
51	52		4	9.6K	CDMA	6.144M
27	53	14	1	19.2k	CDMA	12.288M
28	54		2	19.2k	CDMA	12.288M
52	56		4	9.6K	CDMA	6.144M
29	57	15	1	19.2k	CDMA	12.288M
30	58		2	19.2k	CDMA	12.288M
31	60		4	19.2k	CDMA	12.288M
32	61	16	1	19.2k	CDMA	12.288M
33	62		2	19.2k	CDMA	12.288M
34	64		4	19.2k	CDMA	12.288M
35	65	17	1	19.2k	CDMA	12.288M
36	66		2	19.2k	CDMA	12.288M
37	68		4	19.2k	CDMA	12.288M

Fig. 78

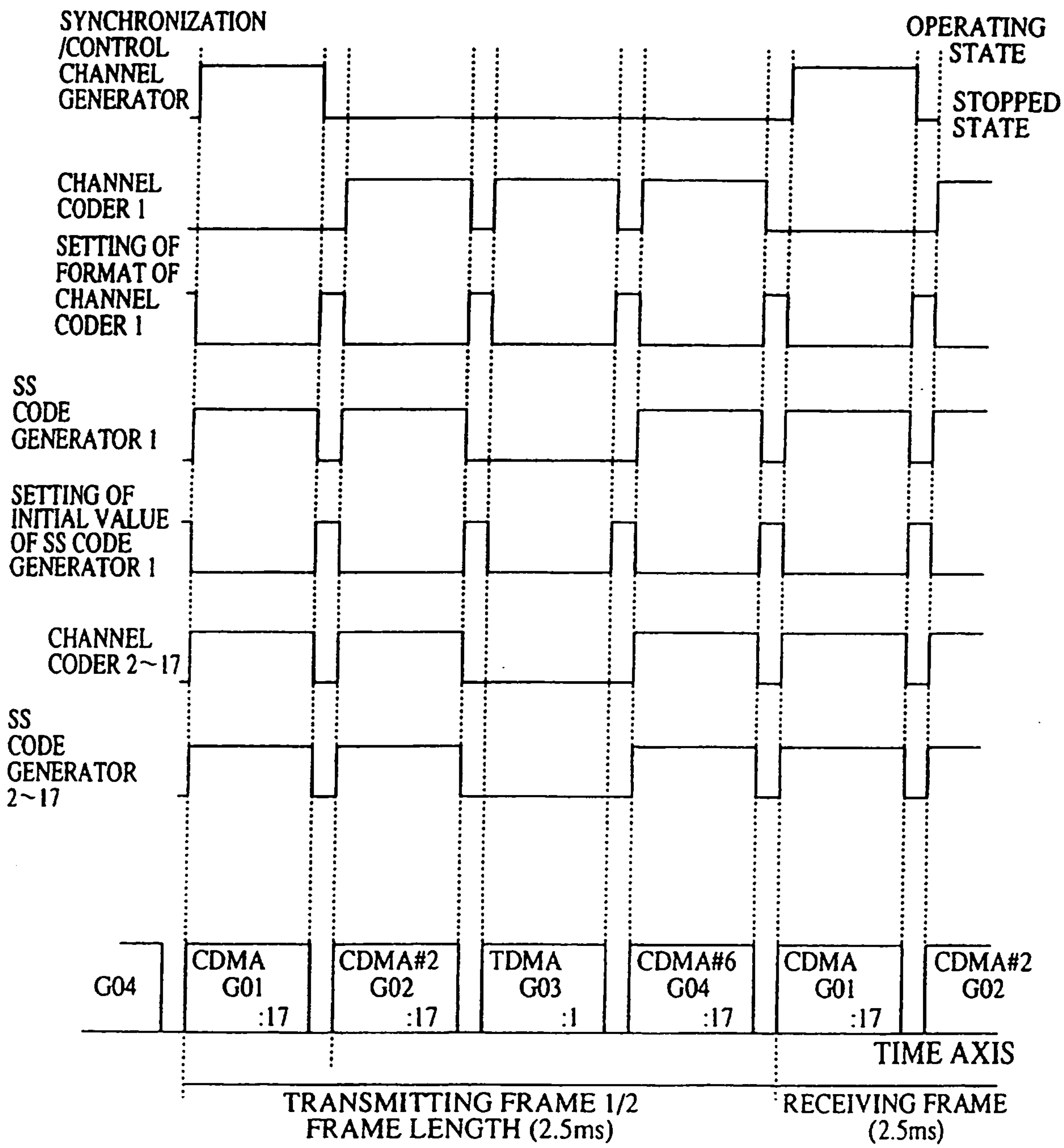

SYNCHRONIZATION /CONTROL CHANNEL GENERATOR
OPERATING STATE
STOPPED STATE
CHANNEL CODER 1
SETTING OF FORMAT OF CHANNEL CODER 1
SS CODE GENERATOR 1
SETTING OF INITIAL VALUE OF SS CODE GENERATOR 1
CHANNEL CODER 2~17
SS CODE GENERATOR 2~17
G04
CDMA G01 :17
CDMA#2 G02 :17
TDMA G03 :1
CDMA#6 G04 :17
CDMA G01 :17
CDMA#2 G02
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME (2.5ms)

Fig. 79

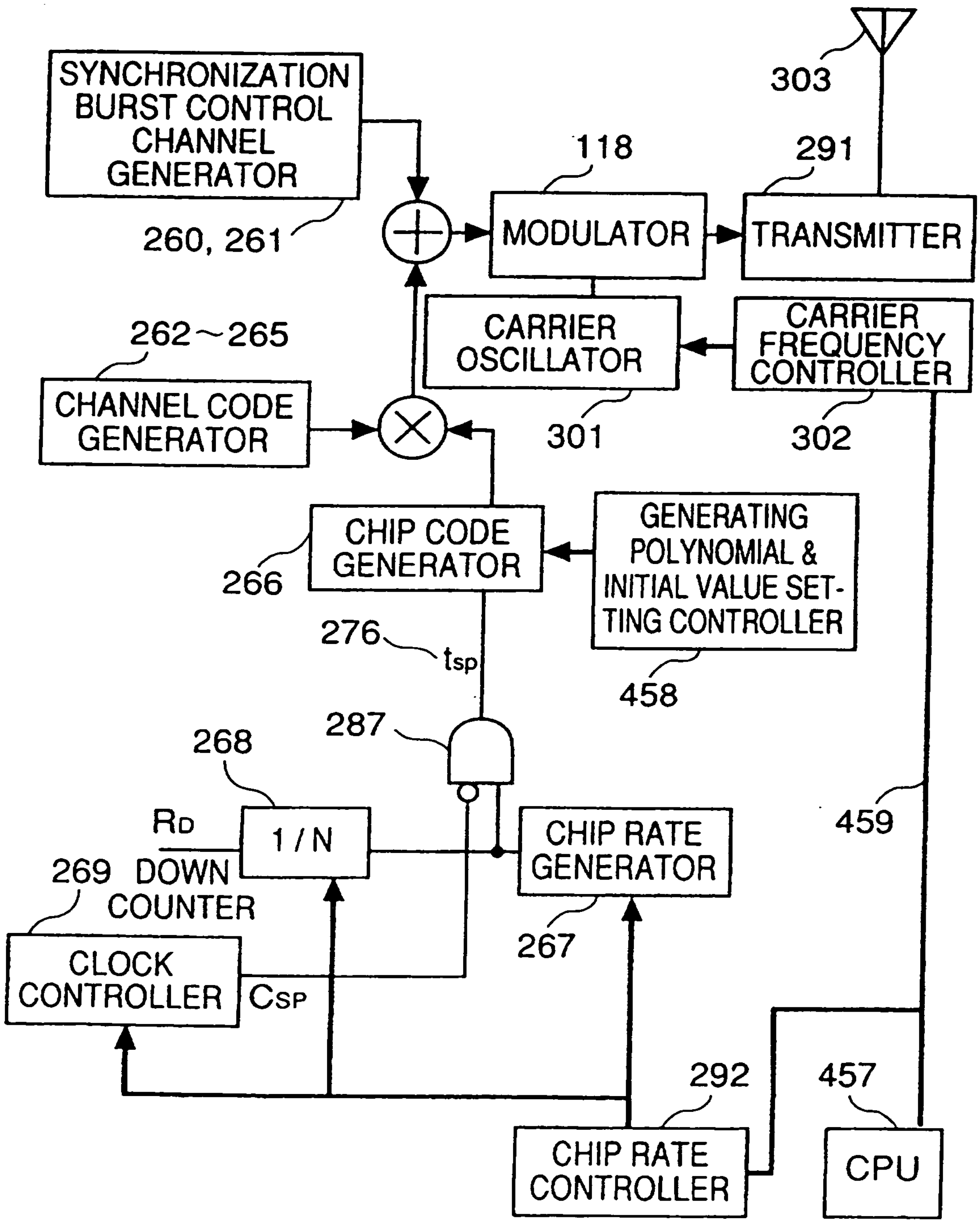

SYNCHRONIZATION BURST CONTROL CHANNEL GENERATOR
260, 261
118
MODULATOR
303
291
TRANSMITTER
CARRIER OSCILLATOR
CARRIER FREQUENCY CONTROLLER
262~265
CHANNEL CODE GENERATOR
301
302
CHIP CODE GENERATOR
266
GENERATING POLYNOMIAL & INITIAL VALUE SET-TING CONTROLLER
458
276
tsp
287
268
RD
1 / N
269 DOWN COUNTER
CHIP RATE GENERATOR
459
267
CLOCK CONTROLLER
CSP
292
457
CHIP RATE CONTROLLER
CPU

Fig. 80

SLOT NO.	FREQ. MHz	TX TYPE	DATA RATE R_D	CHIP RATE $1/t_{SP}$	CHIP CODE POLYNOMIAL	CHIP CODE INITIAL VALUE
1	f_6	CDMA	R_{D1}	$R_{C1}=N_1R_{D1}$	61	3328
2	f_3	CDMA	R_{D2}	$R_{C2}=N_2R_{D2}$	12	2635
3	f_{11}	TDMA	R_{D3}	0	34	9013
4	f_{12}	CDMA	R_{D4}	$R_{C4}=N_4R_{D4}$	07	7540
	CAR-RIER FREQ. CONT.	CHIP RATE CONTROLLER			GENERATING POLY-NOMIAL & INITIAL VALUE SETTING UNIT	

Fig. 81

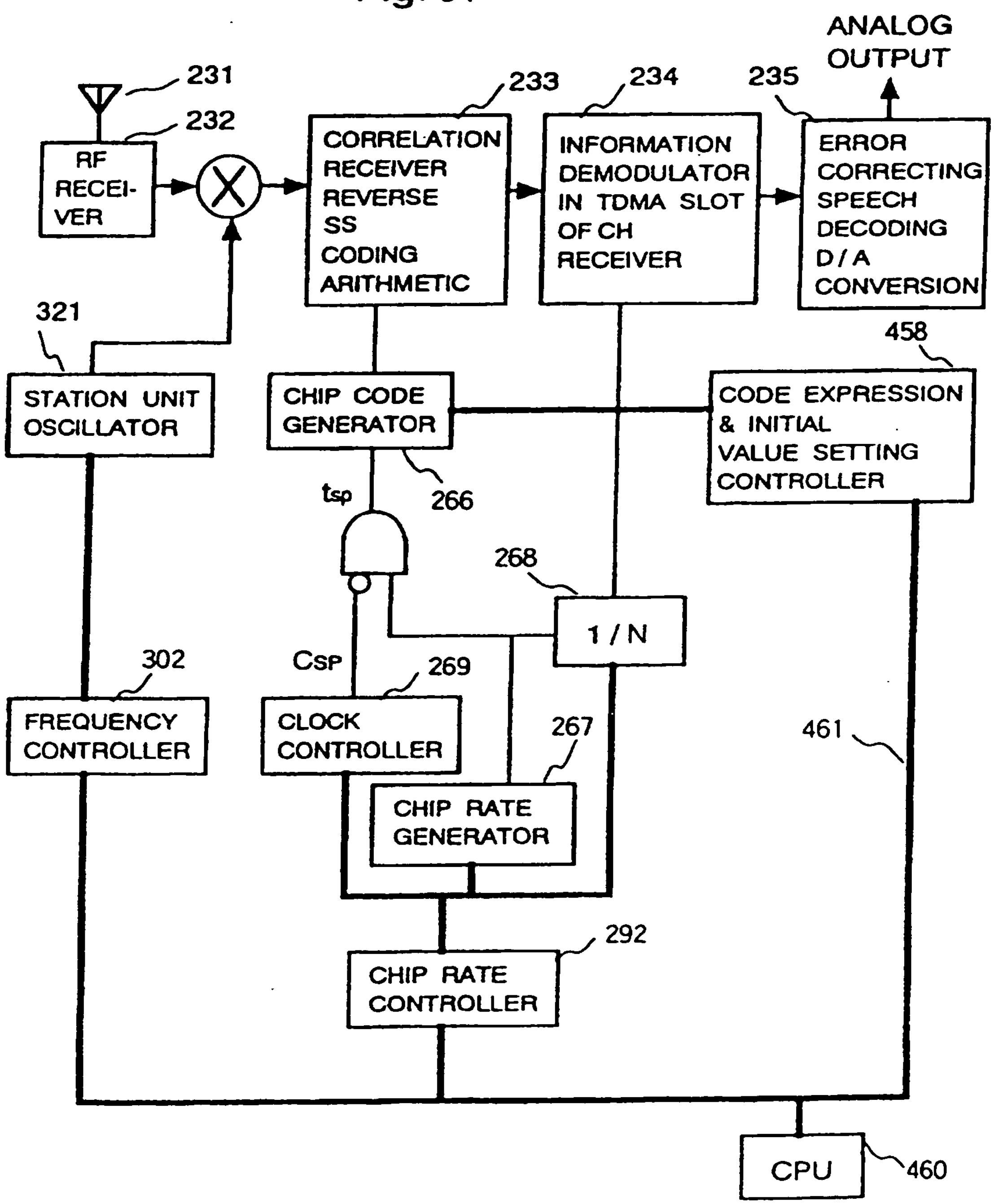
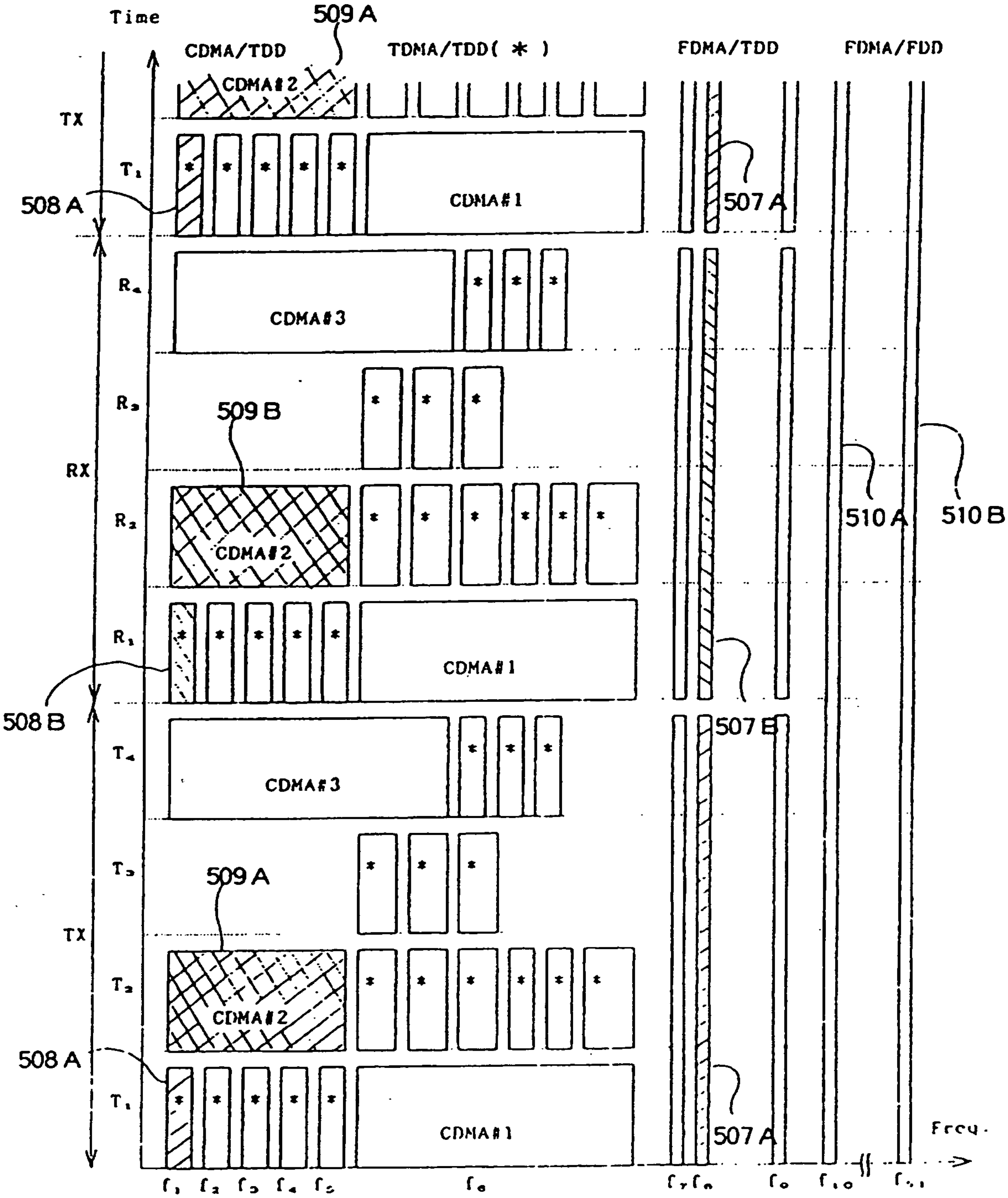

ANALOG OUTPUT
231
232
233
234
235
RF RECEI-VER
CORRELATION RECEIVER REVERSE SS CODING ARITHMETIC
INFORMATION DEMODULATOR IN TDMA SLOT OF CH RECEIVER
ERROR CORRECTING SPEECH DECODING D/A CONVERSION
321
458
STATION UNIT OSCILLATOR
CHIP CODE GENERATOR
CODE EXPRESSION & INITIAL VALUE SETTING CONTROLLER
tsp
266
268
1 / N
302
Csp
269
267
461
FREQUENCY CONTROLLER
CLOCK CONTROLLER
CHIP RATE GENERATOR
292
CHIP RATE CONTROLLER
CPU
460

Fig. 82

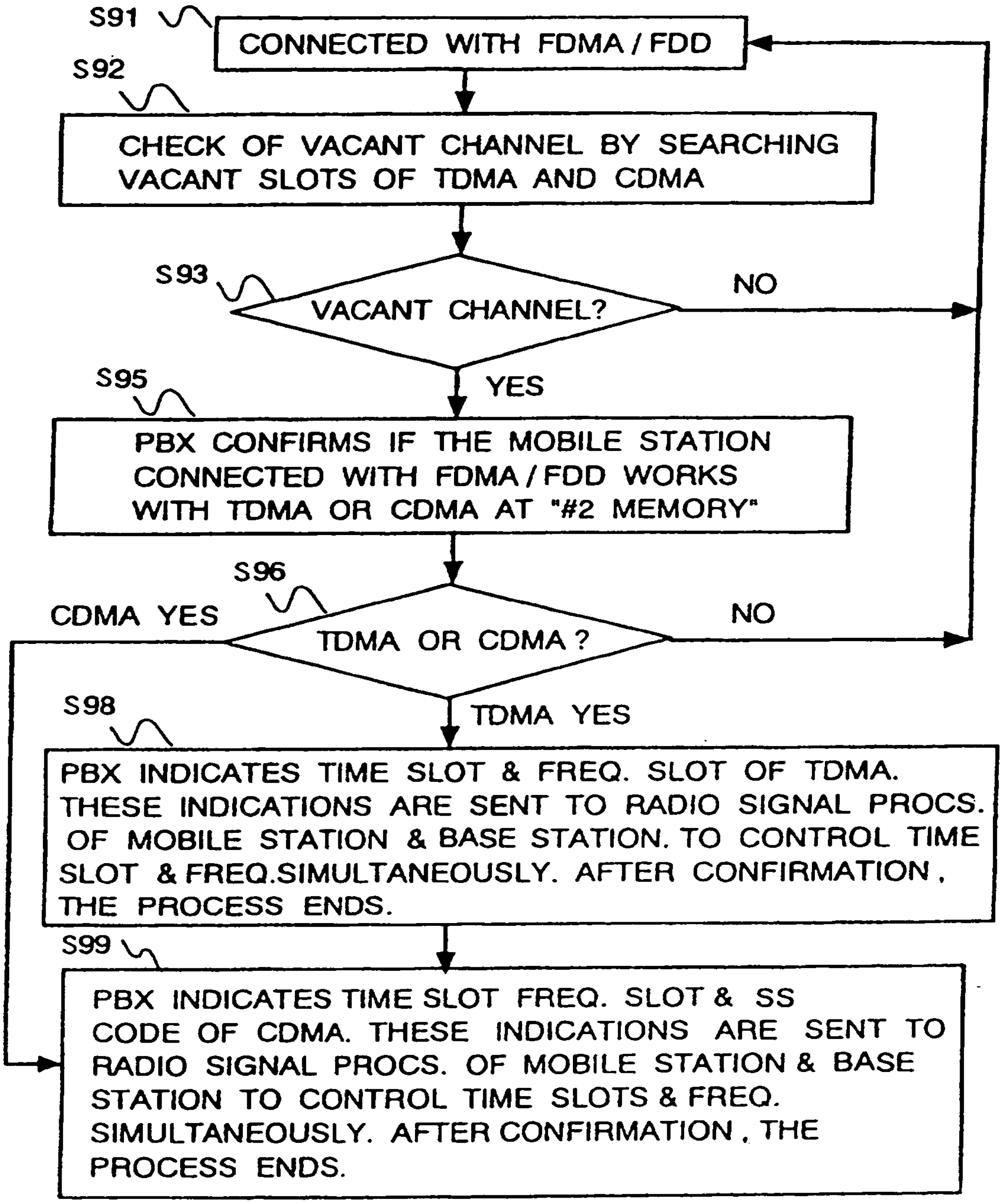
	SLOT NO.	FREQ. MHz	TX TYPE	DATA RATE R_D	CHIP RATE $1/t_{SP}$	CHIP CODE POLYNOMIAL	CHIP CODE INITIAL VALUE
CPU SELECTS THE DESIGNATED SLOT	1	f_6	CDMA	R_{D1}	$R_{C1}=N_1R_{D1}$	61	3328
	2	f_3	CDMA	R_{D2}	$R_{C2}=N_2R_{D2}$	12	2635
	3	f_{11}	TDMA	R_{D3}	0	34	9013
	4	f_{12}	CDMA	R_{D4}	$R_{C4}=N_4R_{D4}$	07	7540
		CAR-RIER FREQ. CONT.	CHIP RATE CONTROLLER			GENERATING POLY-NOMIAL & INITIAL VALUE SETTING CONTROLLER	

Fig.83



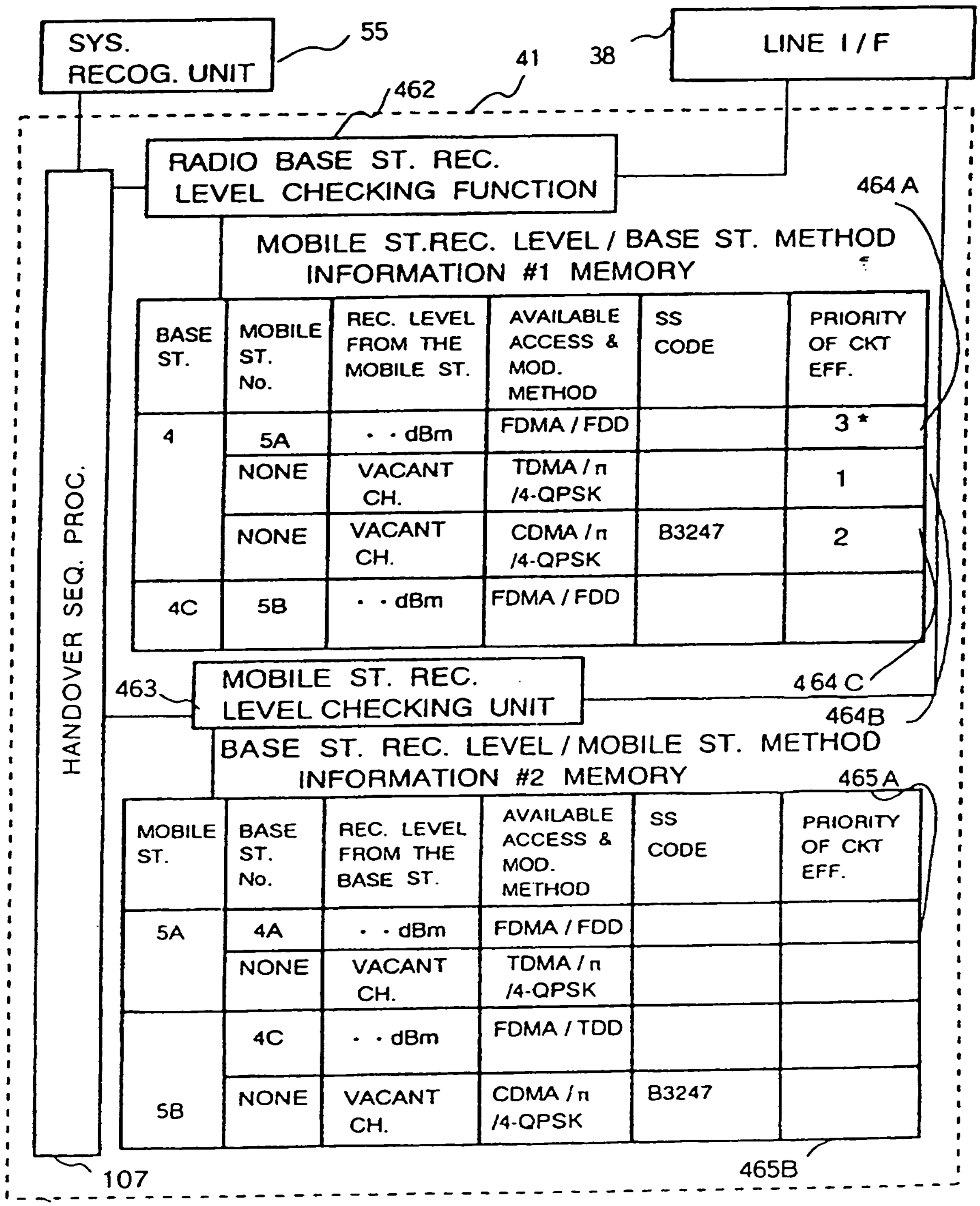
RELATIONSHIP BETWEEN TIME SLOT,
OCCUPIED FREQUENCY AND ACCESS METHOD

Fig. 84



CHANGING PROCEDURE OF THE ACCESS METHOD

Fig. 85



BASE ST.	MOBILE ST. No.	REC. LEVEL FROM THE MOBILE ST.	AVAILABLE ACCESS & MOD. METHOD	SS CODE	PRIORITY OF CKT EFF.
4	5A	· · dBm	FDMA / FDD		3 *
	NONE	VACANT CH.	TDMA / π /4-QPSK		1
	NONE	VACANT CH.	CDMA / π /4-QPSK	B3247	2
4C	5B	· · dBm	FDMA / FDD		

MOBILE ST.	BASE ST. No.	REC. LEVEL FROM THE BASE ST.	AVAILABLE ACCESS & MOD. METHOD	SS CODE	PRIORITY OF CKT EFF.
5A	4A	· · dBm	FDMA / FDD		
	NONE	VACANT CH.	TDMA / π /4-QPSK		
5B	4C	· · dBm	FDMA / TDD		
	NONE	VACANT CH.	CDMA / π /4-QPSK	B3247	

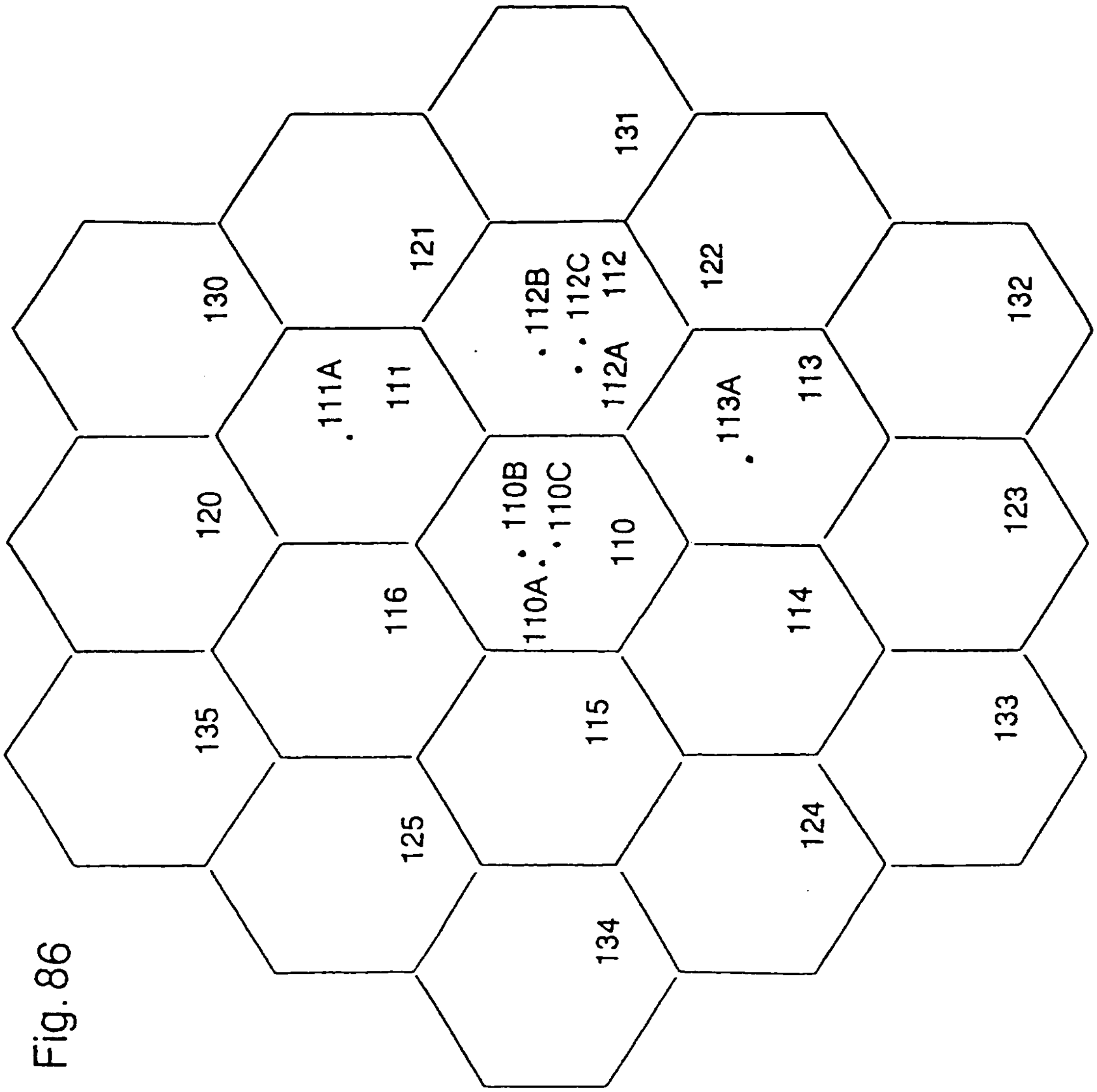

131
121
122
130
112B
112C
112
132
111A
111
112A
113A
113
110B
110C
110
120
123
116
110A
114
135
115
133
125
124
134

Fig. 86

Fig. 87

TABLE 1

AN EXAMPLE OF # 1 MEMORY FORMAT OF THE PRIORITY BASED ON EFFICIENCY OF AVAILABLE ACCESS METHODS

CELL No.	BASE STATION NUMBER	LEVEL	ACCESS METHOD	MODULATION METHOD	SS CODE	SPEECH CODING
110	110A	1	TDMA/TDD	π/4-QPSK		16K
	110B	2	CDMA/TDD	GMSK	B3654	16K
	110C	3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG
111	111A	1	CDMA/TDD	GMSK	B3624	8K
		2	TDMA/TDD	π/4-QPSK		16K
		3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG
112	112A	1	TDMA/TDD	π/4-QPSK		16K
	112B	2	CDMA/TDD	GMSK	B3679	16K
	112C	3	FDMA/TDD	GMSK		12K
		4	FDMA/TDD	π/4-QPSK		32K
		5	FDMA/FDD	FM		ANALOG
113	113A	1	CDMA/TDD	GMSK	B3681	8K
		2	TDMA/TDD	π/4-QPSK		16K
		3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG
135	135A	1	TDMA/TDD	π/4-QPSK		16K
	135B	2	CDMA/TDD	GMSK	B3622	16K
		3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG

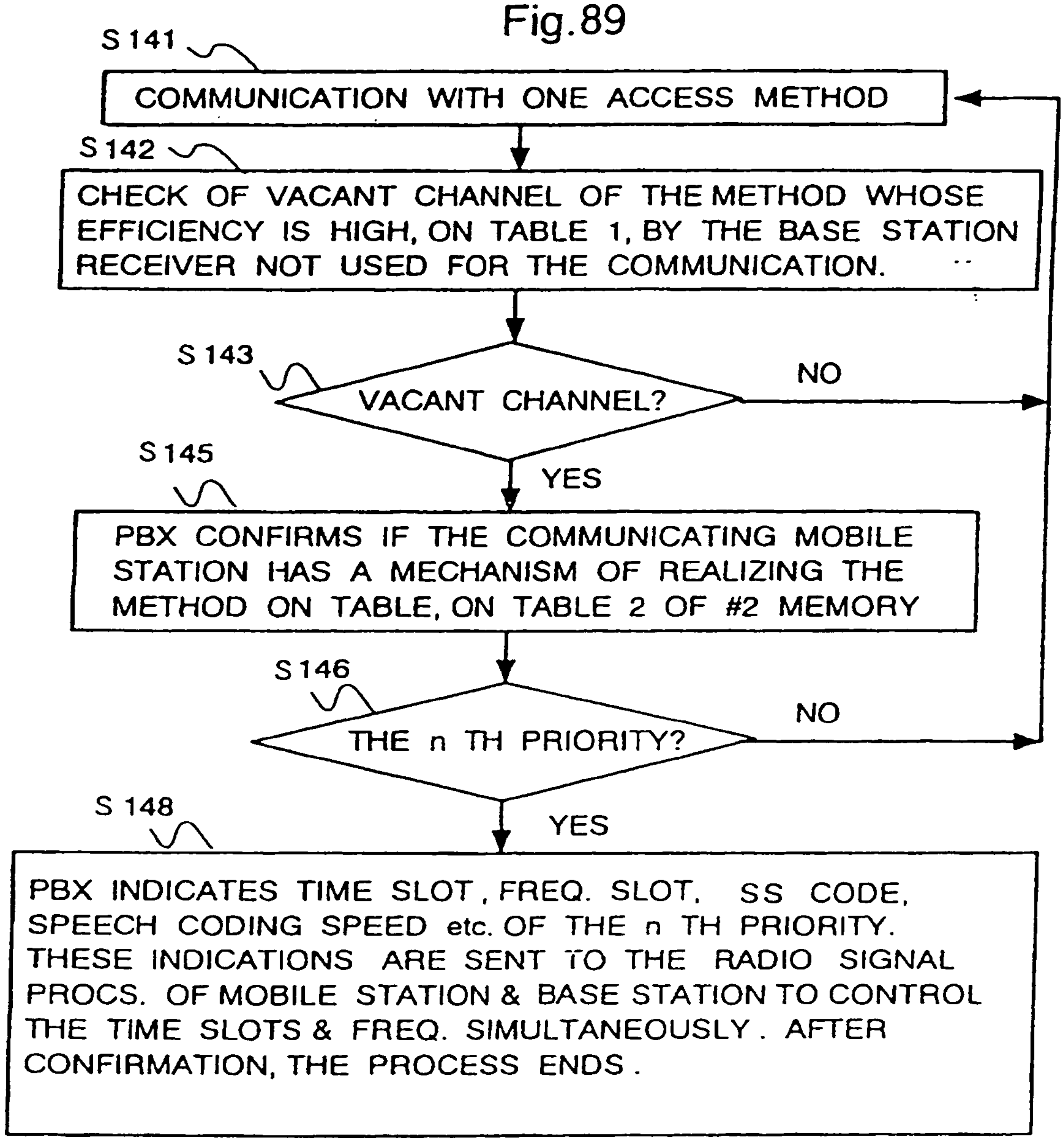
Fig. 88

TABLE 2

#2 MEMORY FORMAT OF MOBILE STATIONS FOR EACH OF CELLS

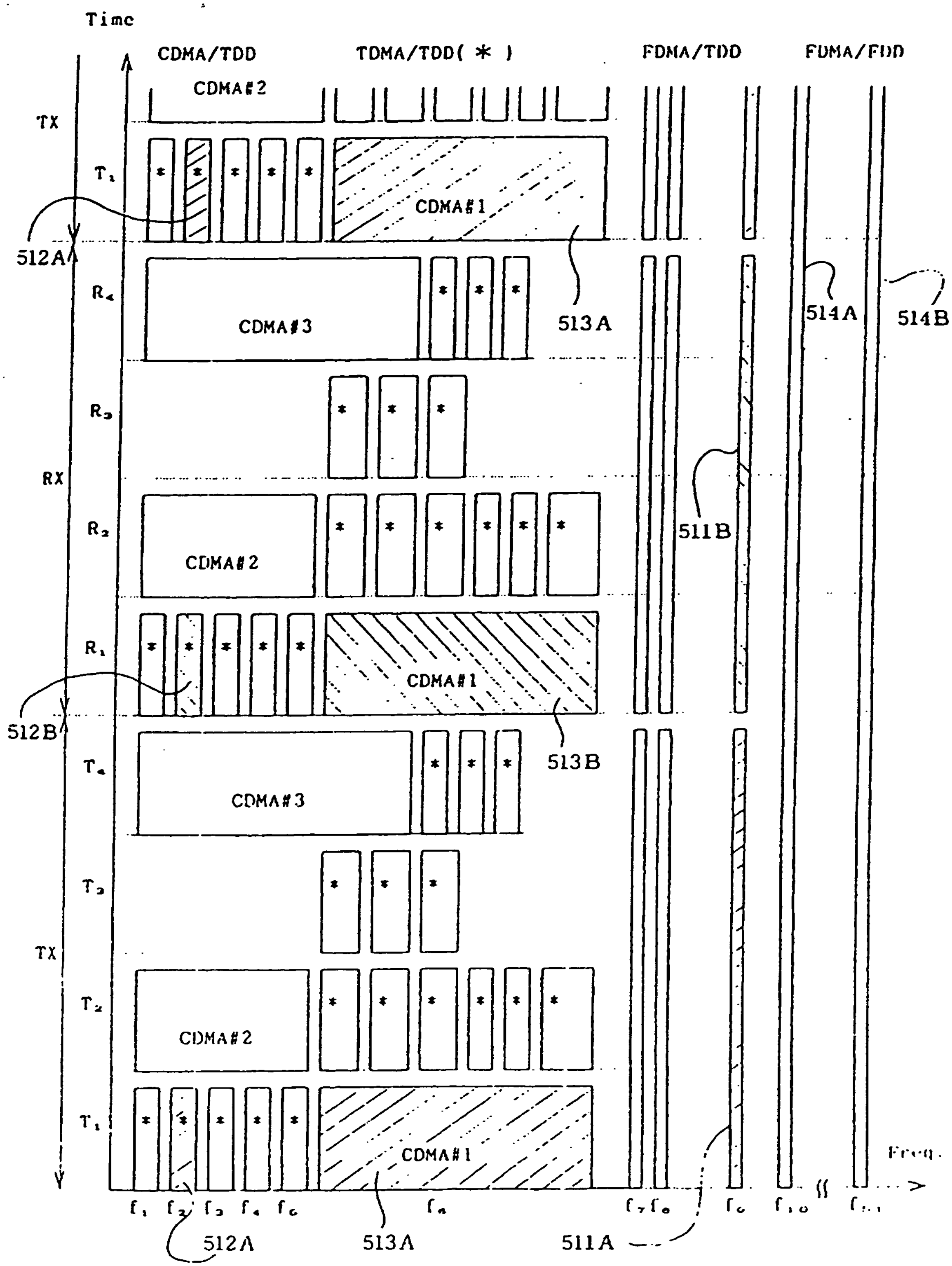
CELL No.	MOBILE STATION NUMBER	LEVEL	ACCESS METHOD	MODULATION METHOD	SS CODE	SPEECH CODING
110	2110 (PORTABLE)	1	TDMA/TDD	π/4-QPSK		16K
		2	CDMA/TDD	GMSK	B3654	16K
		3	FDMA/FDD	FM		ANALOG
	2111 (MOBILE)	1	CDMA/TDD	GMSK	B3624	8K
		2	TDMA/TDD	π/4-QPSK		16K
		3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG
	2113 (MOBILE)	1	TDMA/TDD	π/4-QPSK		16K
		2	CDMA/TDD	π/4-QPSK	B3679	16K
		3	FDMA/TDD	π/4-QPSK		32K
		4	FDMA/FDD	FM		ANALOG
111	2114 (PORTABLE)	1	CDMA/TDD	GMSK	B3681	8K
		2	FDMA/TDD	GMSK		12K
		3	FDMA/FDD	FM		ANALOG
135	2135 (PORTABLE)	1	TDMA/TDD	π/4-QPSK		16K
		3	FDMA/TDD	π/4-QPSK		32K
		4	FDMA/FDD	FM		ANALOG

Fig.89



PROCEDURE OF CHANGING ACCESS METHOD BASED ON THE PRIORITY

Fig. 90



RELATIONSHIP BETWEEN TIME SLOTS AND THE OCCUPIED FREQUENCY

Fig. 91

TABLE 3

CONTROL CHANNEL INFORMATION TO BE NOTIFIED THROUGH CONTROL CHANNEL

CELL No.	FREQ.	ACCESS METHOD	MODULATION METHOD	SS CODE	REMARKS
110	f_1	TDMA/TDD	$\pi/4$-QPSK	B3654-7	Slotted Aloh
	f_6	CDMA/TDD	GMSK		CODE DIVISION
	f_{31}	FDMA/TDD	FSK		Slotted Aloh
	$f_{41/66}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
111	f_3	CDMA/TDD	GMSK	B3621-8	CODE DIVISION
	f_7	TDMA/TDD	$\pi/4$-QPSK		Slotted Aloh
	f_{33}	FDMA/TDD	FSK		Slotted Aloh
	$f_{10/66}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
112	f_0	TDMA/TDD	$\pi/4$-QPSK	B3675-8	Slotted Aloh
	f_{13}	CDMA/TDD	GMSK		CODE DIVISION
	f_{36}	FDMA/TDD	FSK		Slotted Aloh
	$f_{43/66}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
113	f_{11}	CDMA/TDD	GMSK	B3681-4	CODE DIVISION
	f_{16}	TDMA/TDD	$\pi/4$-QPSK		Slotted Aloh
	f_{37}	FDMA/TDD	FSK		Slotted Aloh
	$f_{20/67}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
135	f_2	TDMA/TDD	$\pi/4$-QPSK	B3622-5	Slotted Aloh
	f_0	CDMA/TDD	GMSK		CODE DIVISION
	f_{32}	FDMA/TDD	FSK		Slotted Aloh
	$f_{22/60}$	FDMA/FDD	SPEECH FSK		Slotted Aloh

Fig. 92

TABLE 4 INFORMATION CHANNEL INFORMATION TO BE NOTIFIED FROM CONTROL CHANNEL

CELL No.	VA-CAN-CY ?	FREQ.	ACCESS METHOD	MODULATION METHOD	SS CODE	REMARKS
110	YES	f_{4}	TDMA/TDD	π/4-QPSK		
	YES	f_{10}	CDMA/TDD	GMSK	B4654-7	CODE DIVISION
	NO	f_{24}	FDMA/TDD	FSK		
	YES	$f_{31/76}$	FDMA/FDD	FM		
111	YES	f_{14}	CDMA/TDD	GMSK	B4621-8	CODE DIVISION
	YES	f_{20}	TDMA/TDD	π/4-QPSK		
	YES	f_{30}	FDMA/TDD	FSK		
	YES	$f_{6/57}$	FDMA/FDD	FM		
112	YES	f_{24}	TDMA/TDD	π/4-QPSK		
	YES	f_{36}	CDMA/TDD	GMSK	B4675-8	CODE DIVISION
	YES	f_{44}	FDMA/TDD	FSK		
	YES	$f_{20/60}$	FDMA/FDD	FM		
113	YES	f_{6}	CDMA/TDD	GMSK	B4681-4	CODE DIVISION
	YES	f_{23}	TDMA/TDD	π/4-QPSK		
	YES	f_{20}	FDMA/TDD	FSK		
	YES	$f_{40/77}$	FDMA/FDD	FM		
≈	≈	≈	≈	≈	≈	≈
135	YES	f_{13}	TDMA/TDD	π/4-QPSK		
	YES	f_{20}	CDMA/TDD	GMSK	B4622-5	CODE DIVISION
	NO	f_{35}	FDMA/TDD	FSK		
	YES	$f_{55/70}$	FDMA/FDD	FM		

Fig.93

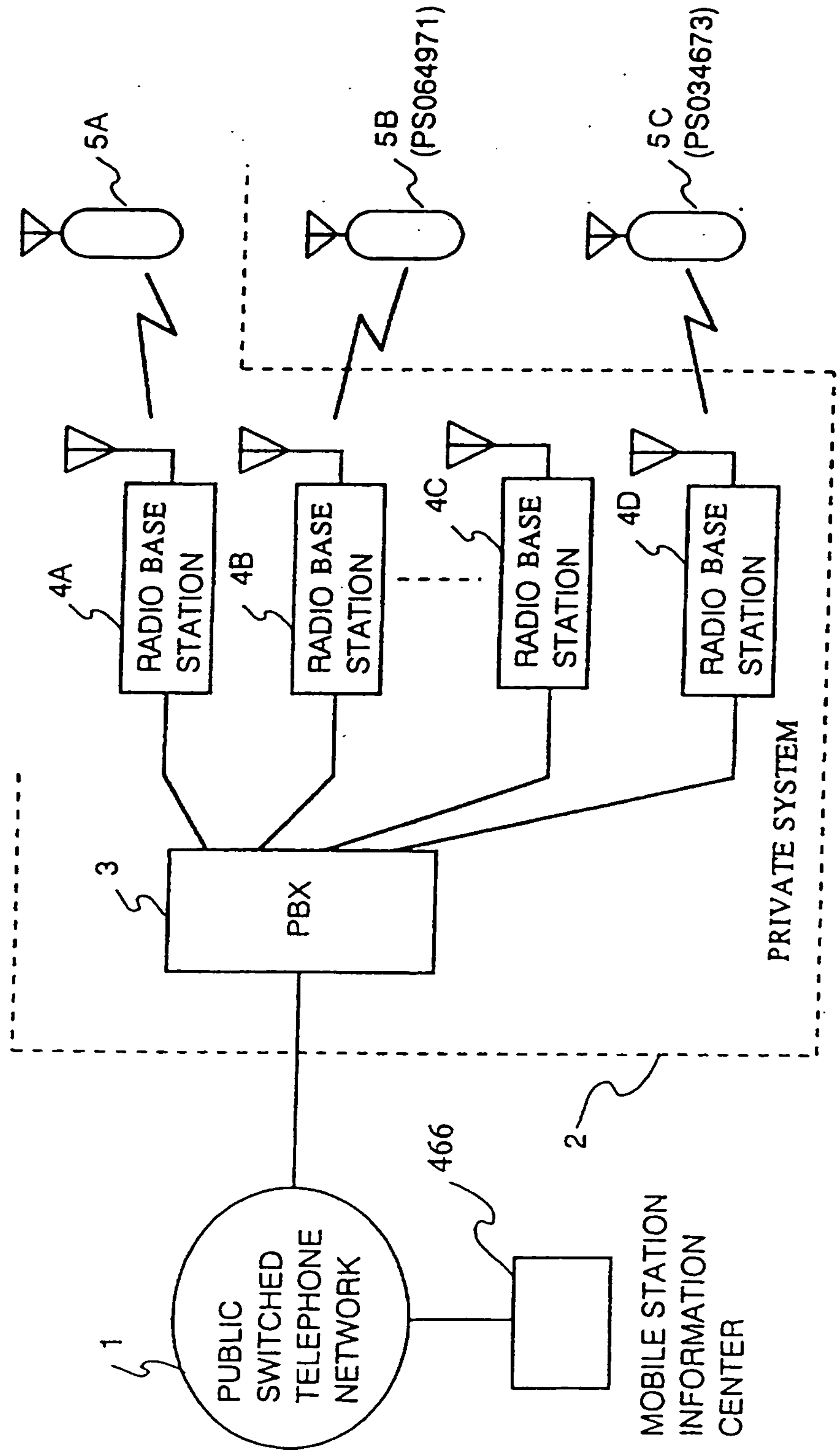
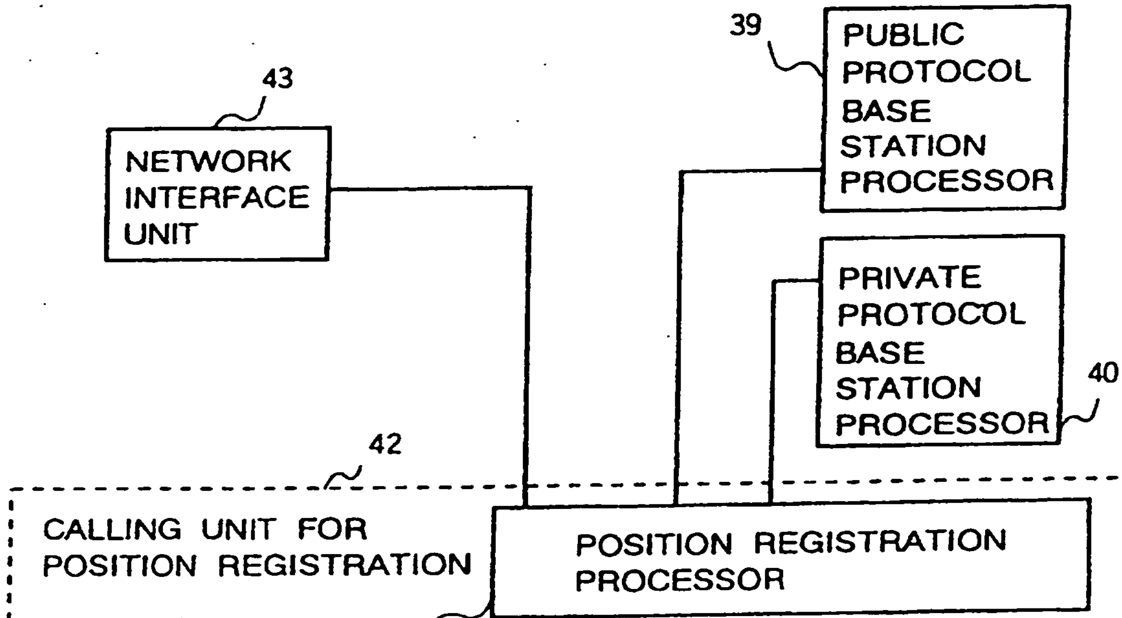

5A
5B
(PS064971)
5C
(PS034673)
4A
RADIO BASE STATION
4B
RADIO BASE STATION
4C
RADIO BASE STATION
4D
RADIO BASE STATION
3
PBX
PRIVATE SYSTEM
2
1
PUBLIC SWITCHED TELEPHONE NETWORK
466
MOBILE STATION INFORMATION CENTER

Fig. 94



P S NO.	ACCESS METHOD	MODULATION METHOD	SPEECH CODING	THE OTHER INFORMATION
PS064971	FDMA/TDD TDMA/TDD CDMA/TDD	FM π/4-QPSK GMSK	ANALOG 32K ADPCM 8K CELP	
PS034673	FDMA/TDD CDMA/TDD	FM GMSK	ANALOG 8K CELP	
PS078911	FDMA/TDD TDMA/TDD	FM π/4-QPSK	ANALOG 32K ADPCM	
PS024592	FDMA/TDD TDMA/TDD CDMA/TDD	FM π/4-QPSK GMSK	ANALOG 32K ADPCM 8K CELP	
PS092373	FDMA/TDD TDMA/TDD CDMA/TDD	FM π/4-QPSK GMSK	ANALOG 32K ADPCM 8K CELP	

Fig. 95

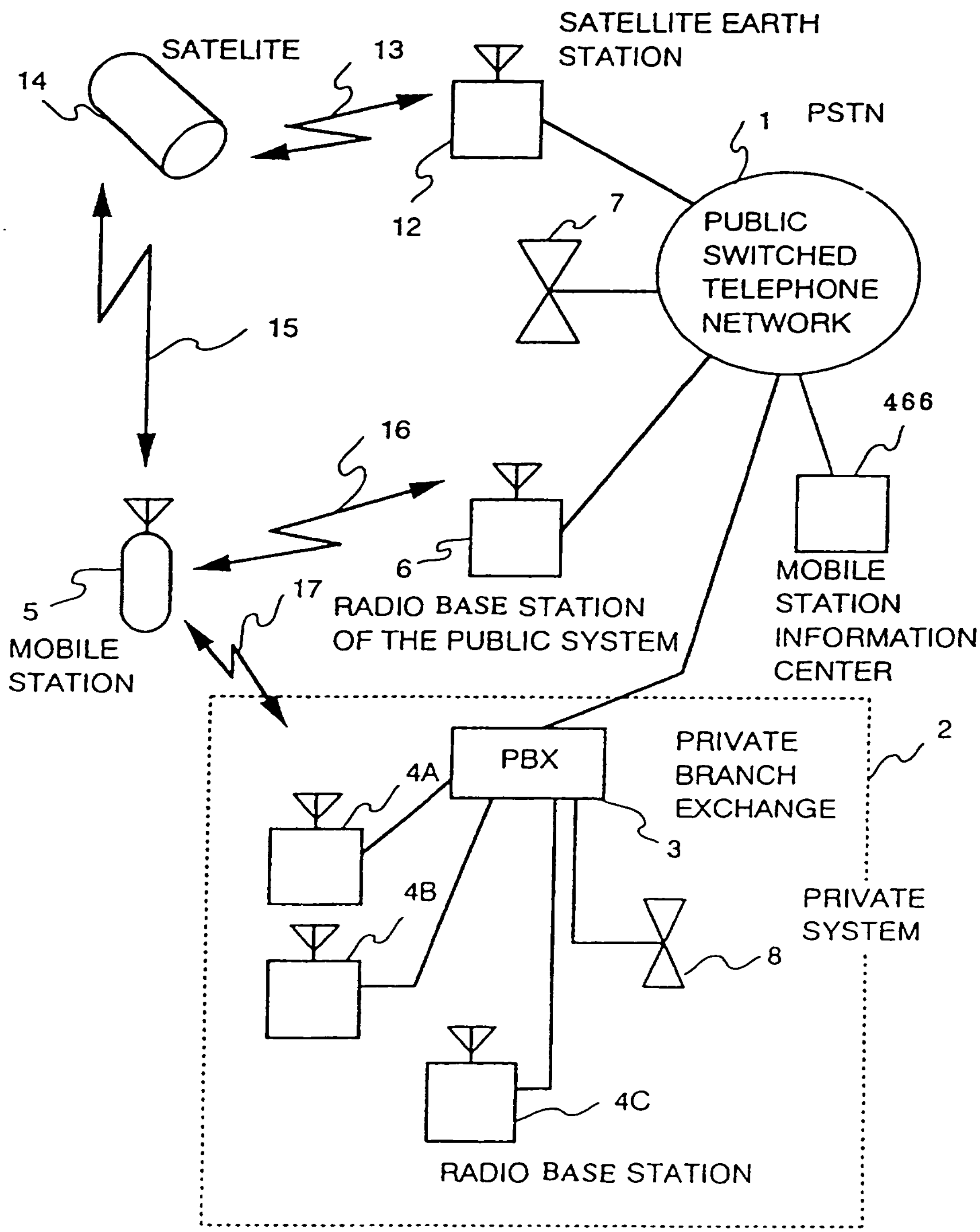
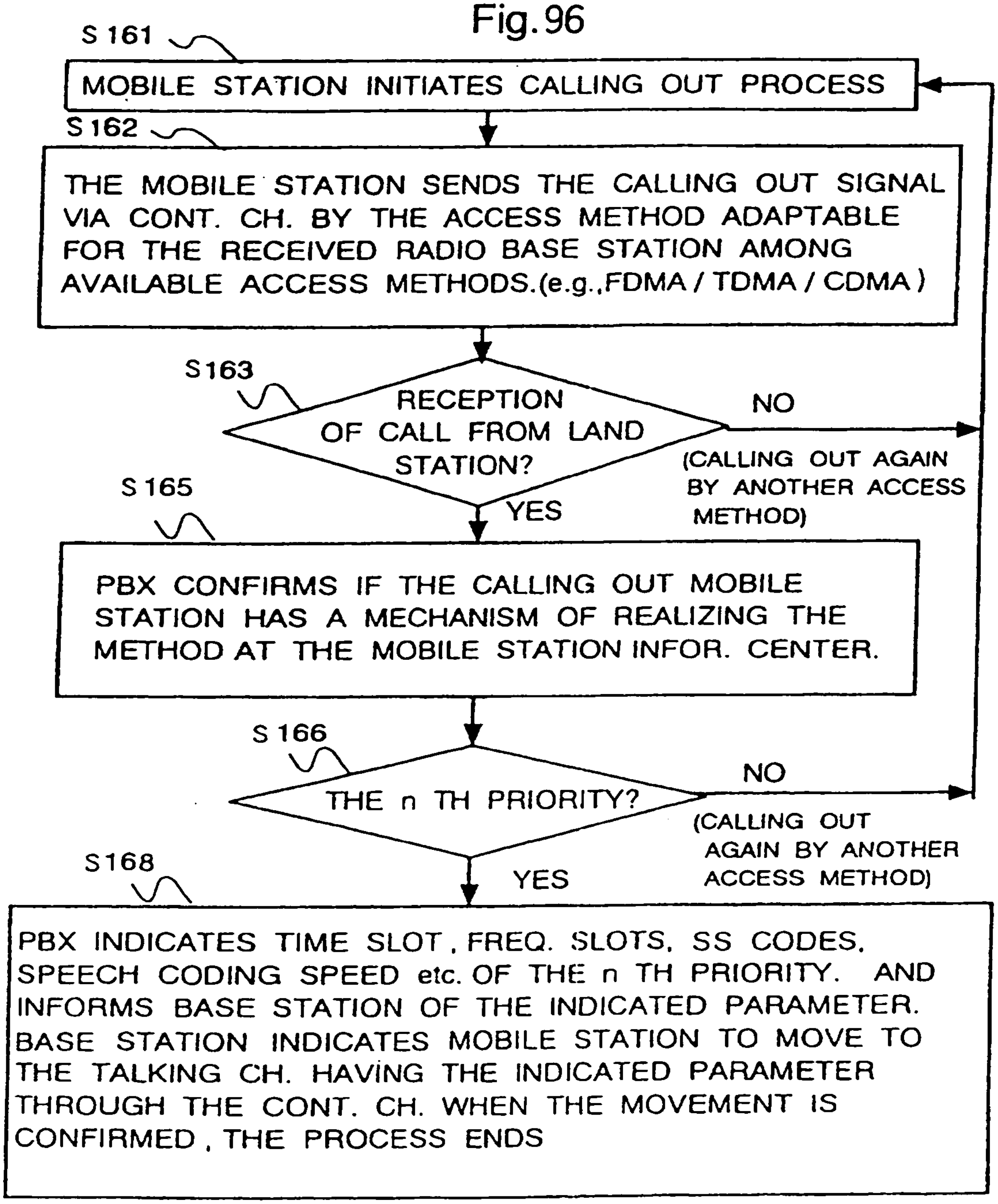

SATELITE
14
13
SATELLITE EARTH
STATION
12
1
PSTN
7
PUBLIC
SWITCHED
TELEPHONE
NETWORK
15
466
16
6
RADIO BASE STATION
OF THE PUBLIC SYSTEM
5
MOBILE
STATION
17
MOBILE
STATION
INFORMATION
CENTER
2
PBX
PRIVATE
BRANCH
EXCHANGE
4A
3
4B
PRIVATE
SYSTEM
8
4C
RADIO BASE STATION

Fig. 96



ACCESS PROCEDURE OF LINK LEVEL
WHEN CALLING OUT FROM MOBILE STATION

Fig.97

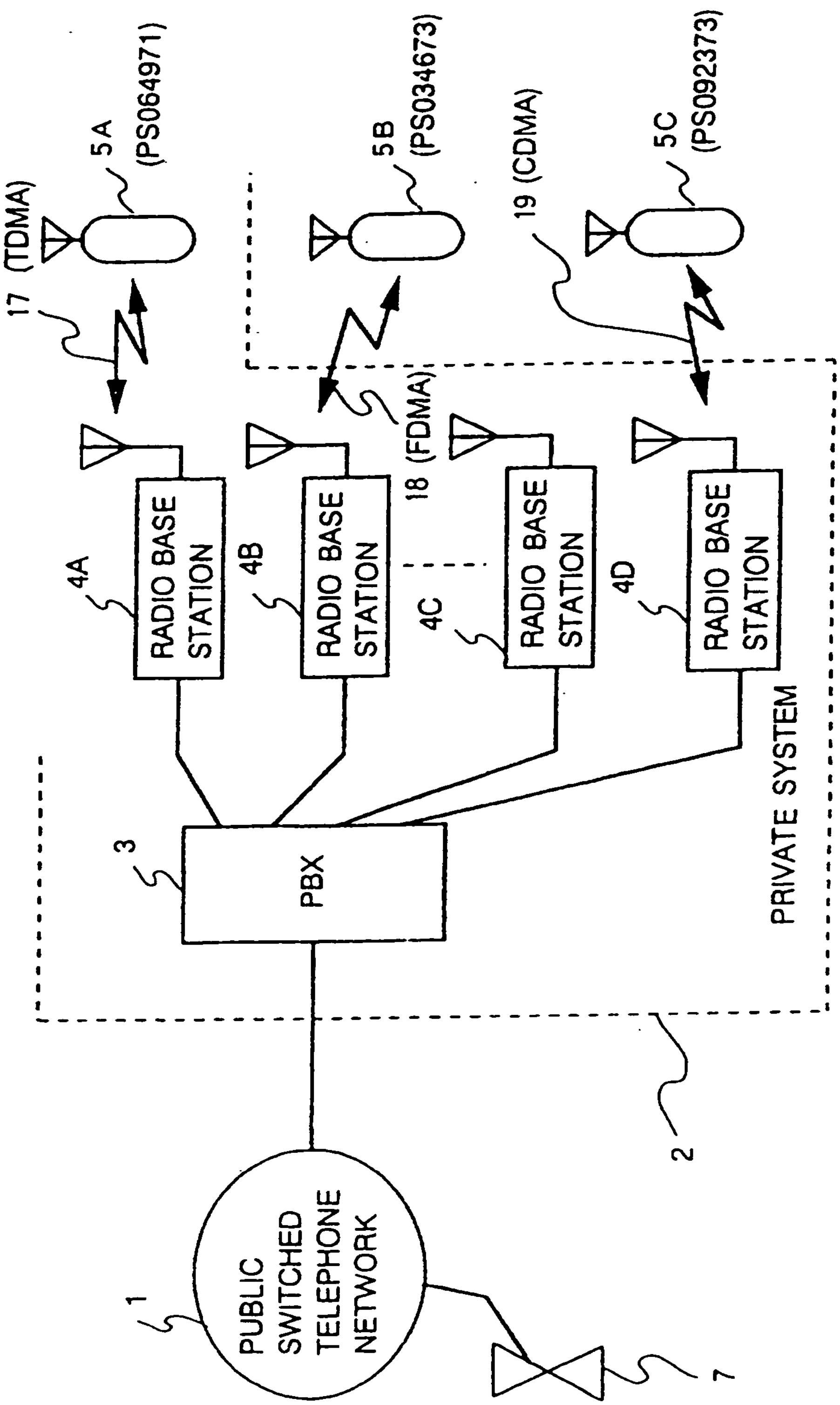
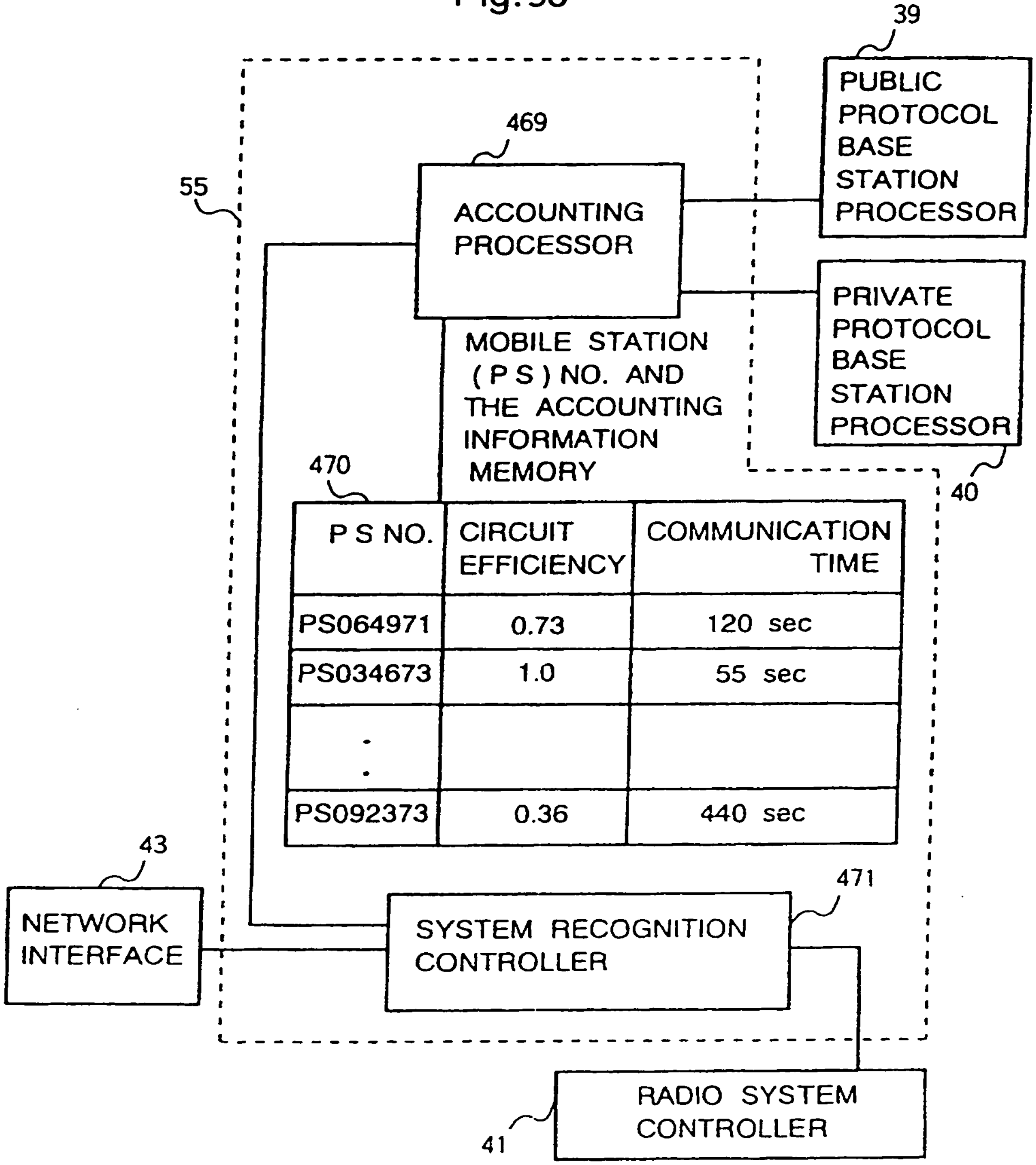

1
PUBLIC SWITCHED TELEPHONE NETWORK
7
3
PBX
4A
RADIO BASE STATION
4B
RADIO BASE STATION
4C
RADIO BASE STATION
4D
RADIO BASE STATION
17 (TDMA)
18 (FDMA)
19 (CDMA)
5A (PS064971)
5B (PS034673)
5C (PS092373)
PRIVATE SYSTEM
2

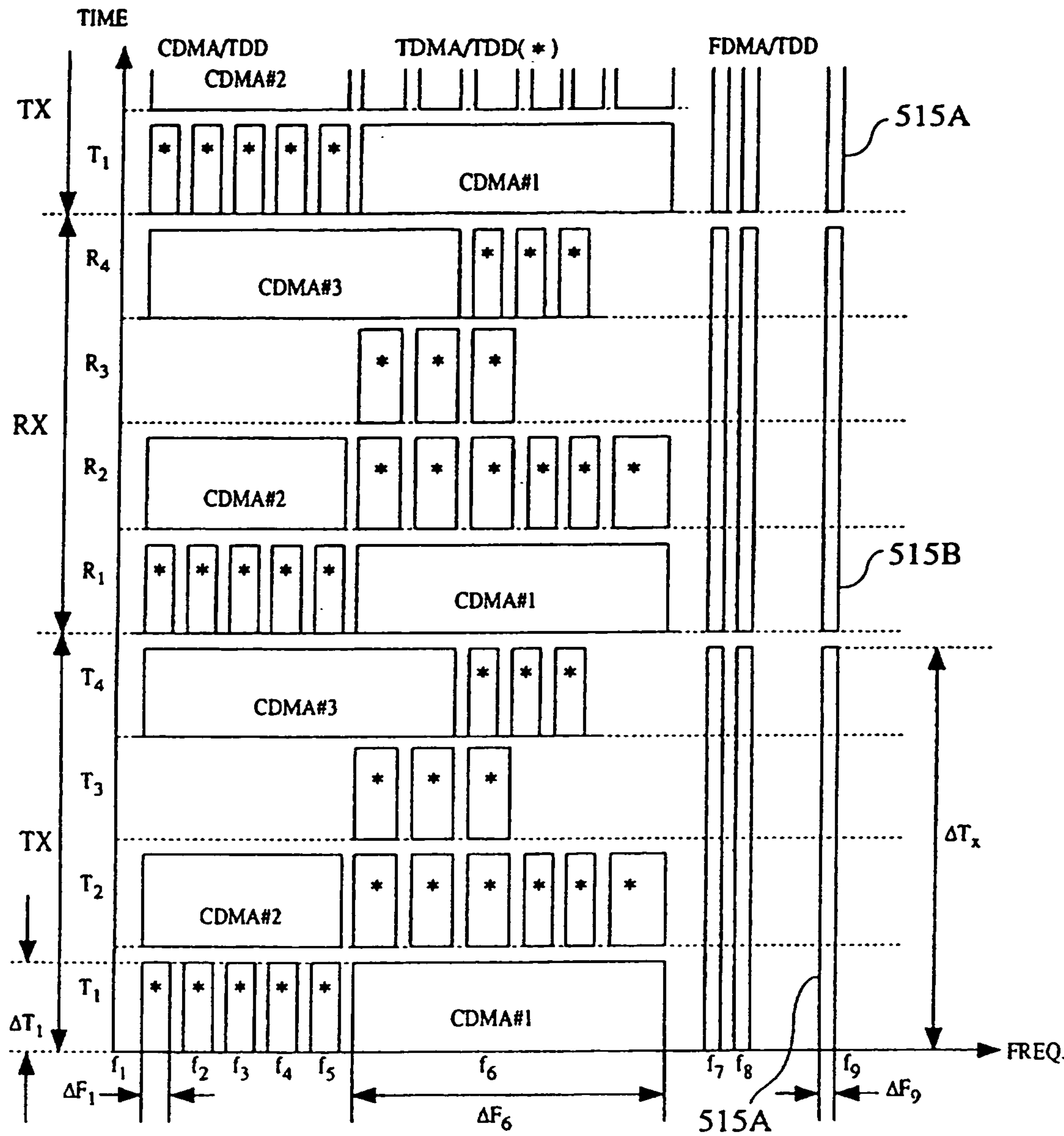
Fig. 98



P S NO.	CIRCUIT EFFICIENCY	COMMUNICATION TIME
PS064971	0.73	120 sec
PS034673	1.0	55 sec
. .		
PS092373	0.36	440 sec

EXAMPLE OF ACCOUNTING (COMMUICATION CHANNEL EFFICIENCY COMMUNICATION TIME) MEMORY FORMAT OF PBX

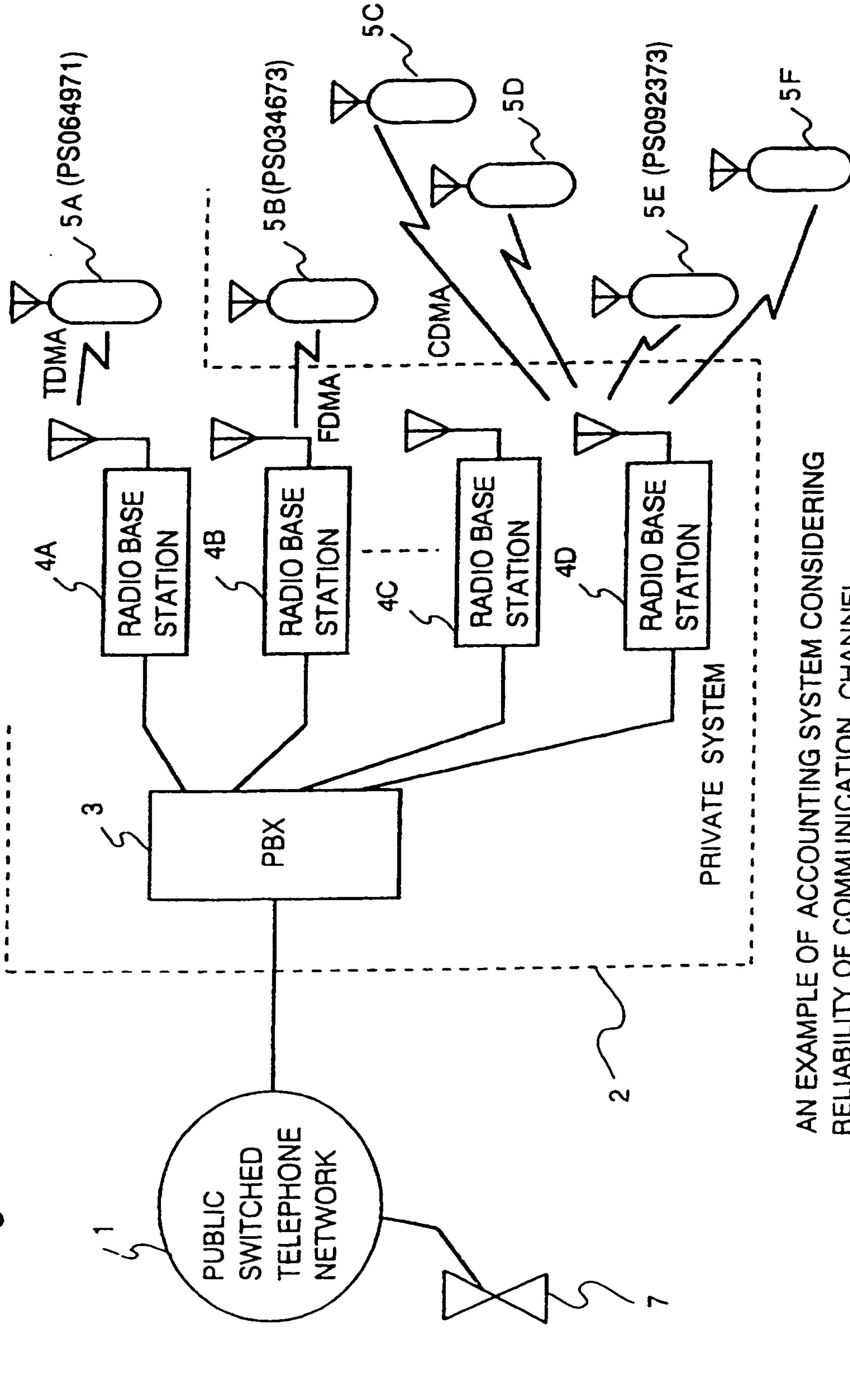
Fig. 99



FDMA-f_9 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_9 \times \Delta T_X$
TDMA-f_1 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_1 \times \Delta T_1$
CDMA-f_6 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_6 \times \Delta T_1/N$

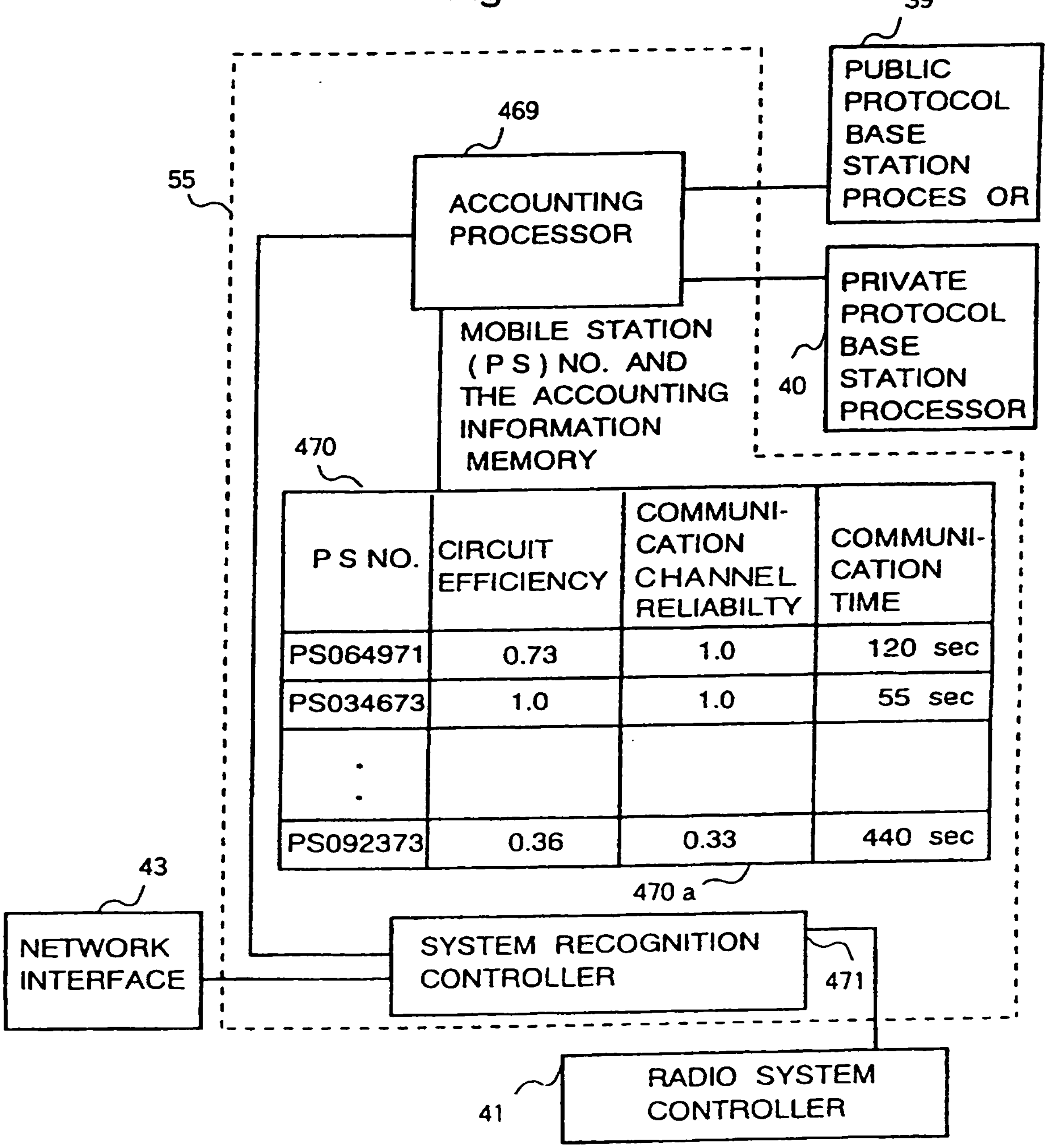
EXAMPLE OF SETTING COMMUNICATION CHANNEL EFFICIENCY BASED ON TIME SLOT AND OCCUPIED FREQUENCY

Fig.100



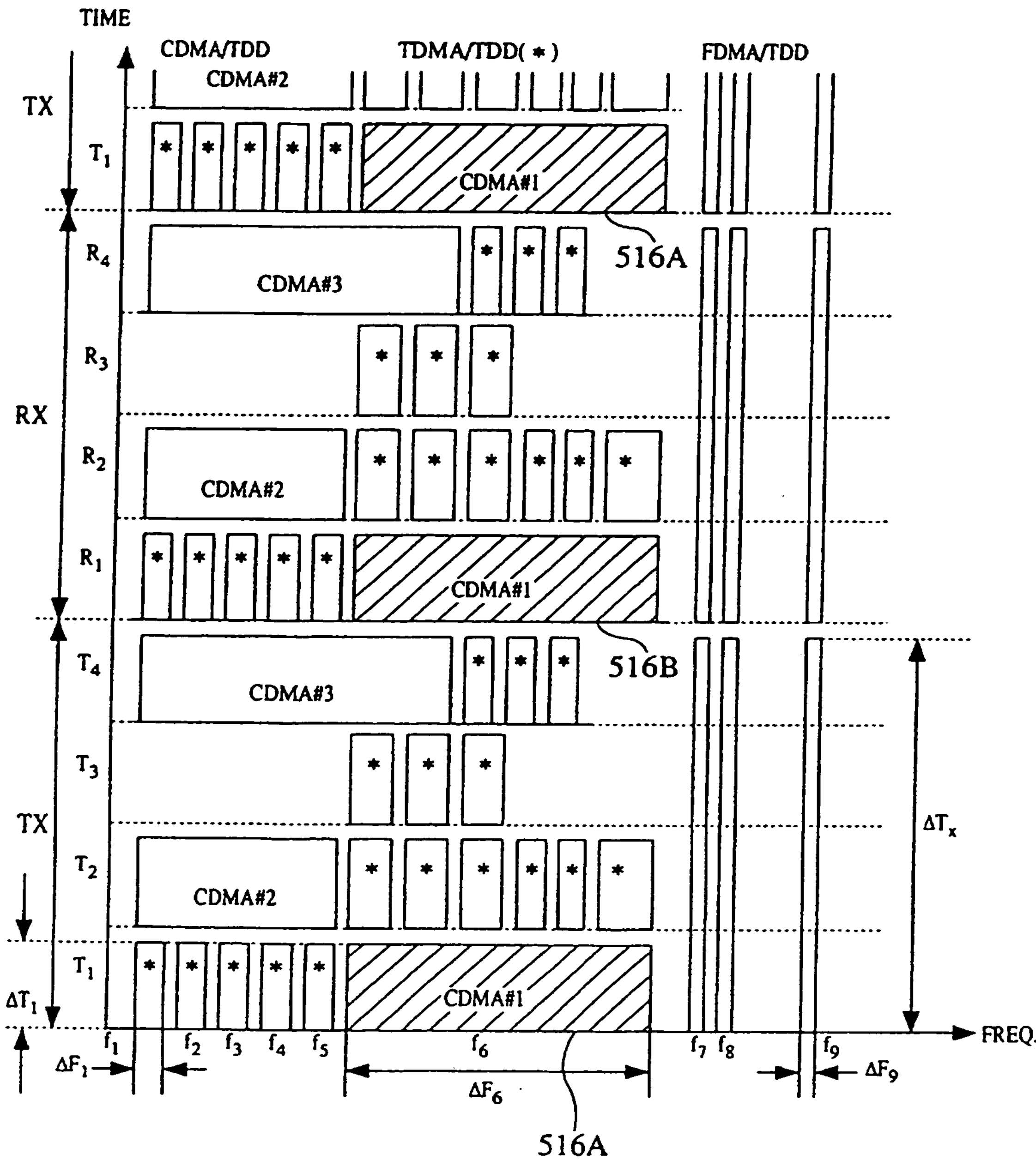
AN EXAMPLE OF ACCOUNTING SYSTEM CONSIDERING RELIABILITY OF COMMUNICATION CHANNEL

Fig. 101



P S NO.	CIRCUIT EFFICIENCY	COMMUNI-CATION CHANNEL RELIABILTY	COMMUNI-CATION TIME
PS064971	0.73	1.0	120 sec
PS034673	1.0	1.0	55 sec
⋮			
PS092373	0.36	0.33	440 sec

Fig. 102



FDMA-f_9 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_9 \times \Delta T_X$

TDMA-f_1 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_1 \times \Delta T_1$

CDMA-f_6 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_6 \times \Delta T_1/N$

CDMA COMMUNICATION CHANNEL RELIABILITY = S/n

THE CURRENT NUMBER OF COMMUNICATION CHANNELS IN USE : n (THE RELIABILITY IS HIGH WHEN n ≧1)

Fig.103

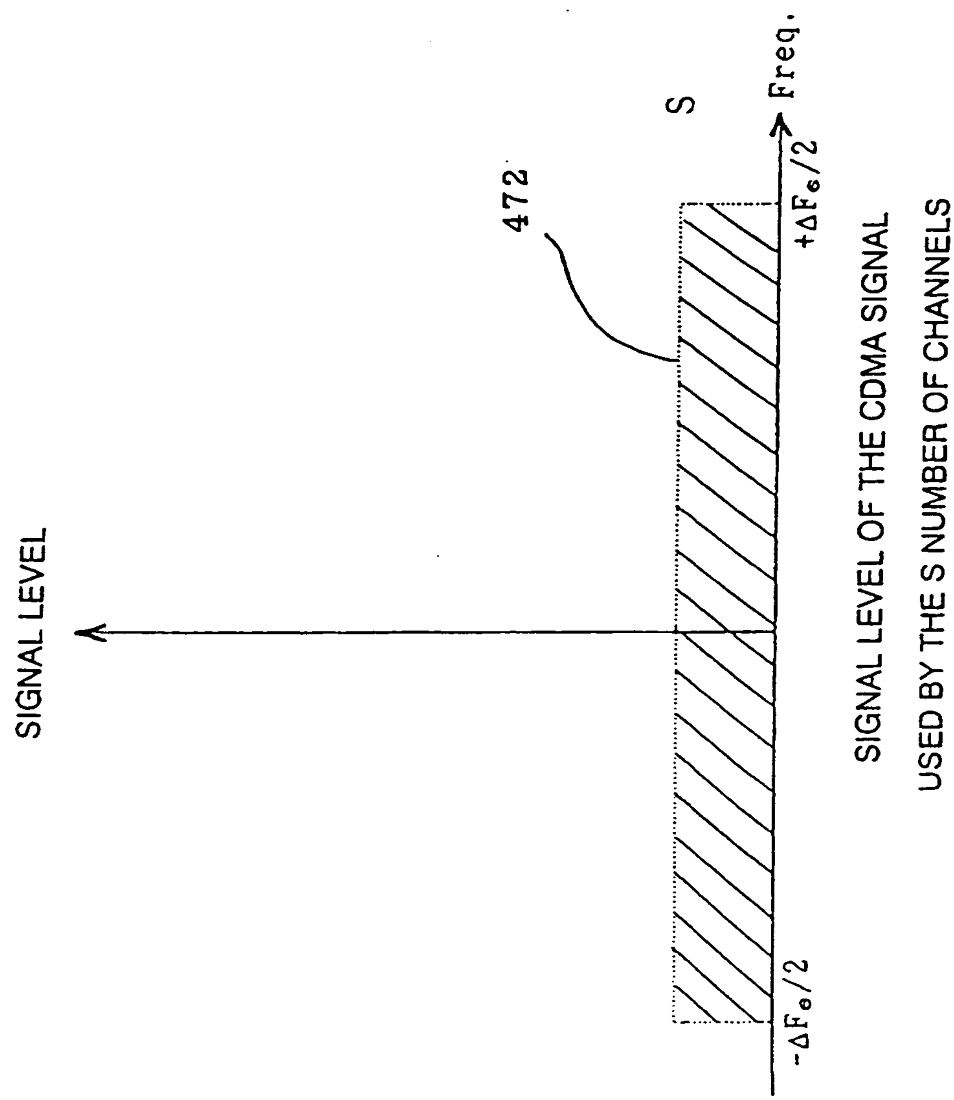

SIGNAL LEVEL
472
S
Freq.
$+\Delta F_6/2$
$-\Delta F_6/2$
SIGNAL LEVEL OF THE CDMA SIGNAL
USED BY THE S NUMBER OF CHANNELS

Fig.104

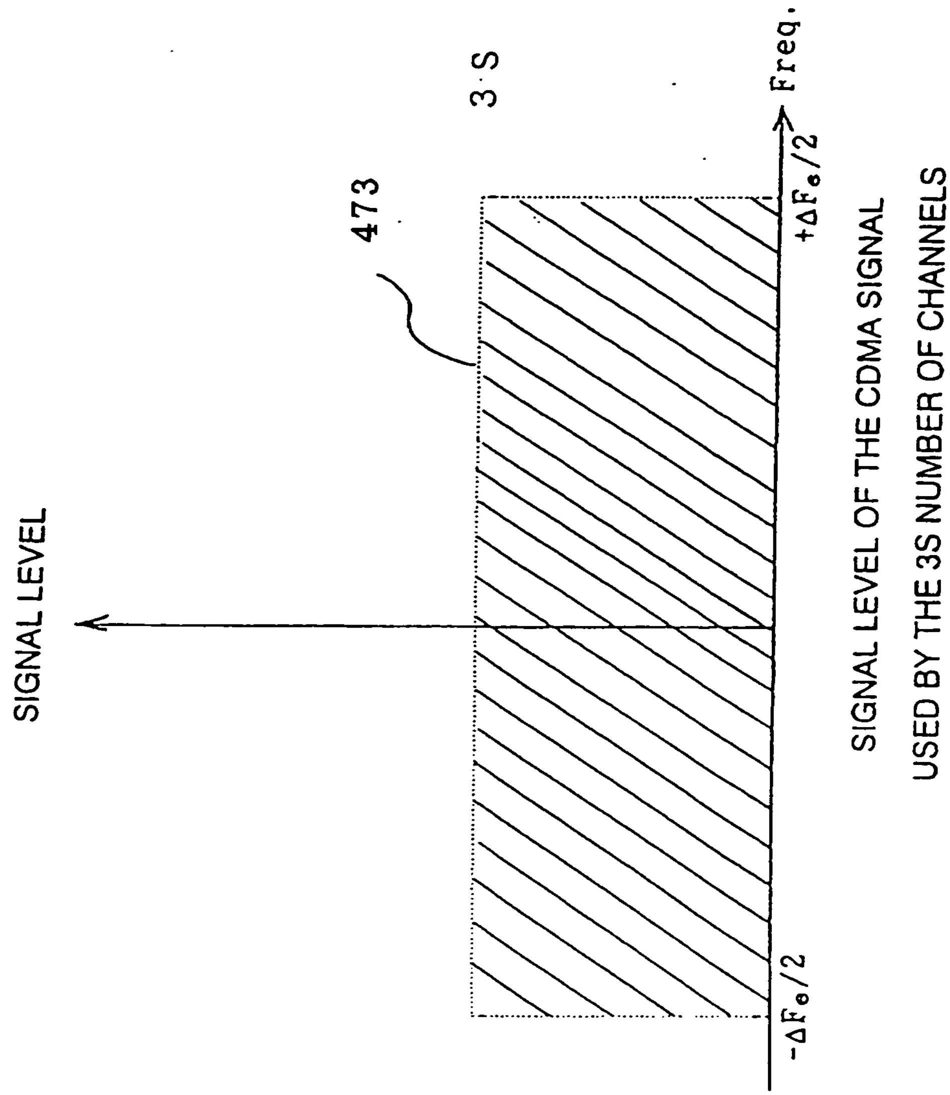
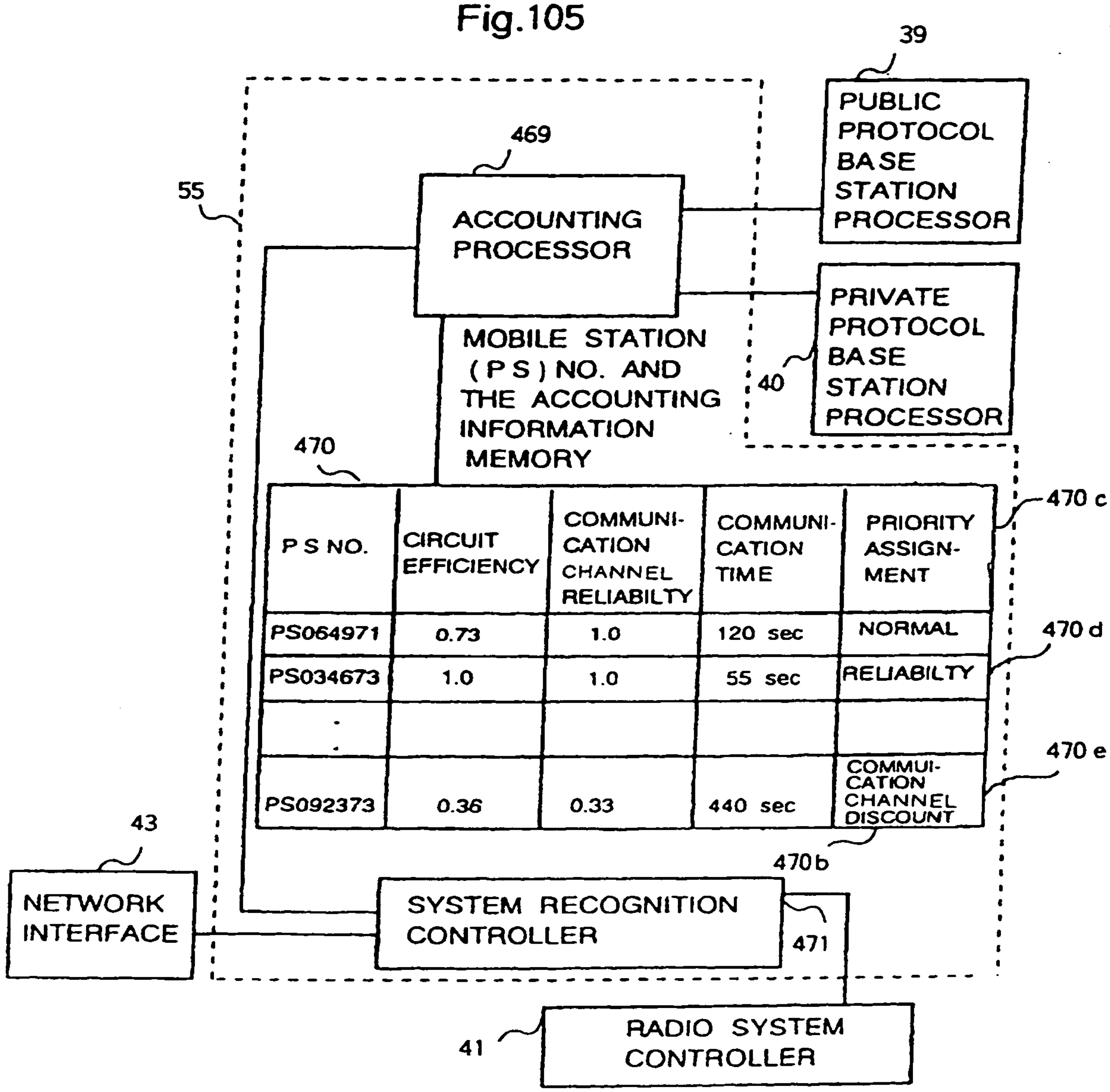

SIGNAL LEVEL
473
3·S
Freq.
$+\Delta F_e/2$
$-\Delta F_e/2$
SIGNAL LEVEL OF THE CDMA SIGNAL
USED BY THE 3S NUMBER OF CHANNELS

Fig.105



AN EXAMPLE OF THE ACCOUNTING (COMMUICATION CHANNEL EFFICIENCY · COMMUNCATION CHANNEL RELIABILTY · COMMUNICATION TIME · PRIORITY ASSIGNMENT) MEMORY FORMAT OF PBX

Fig.106

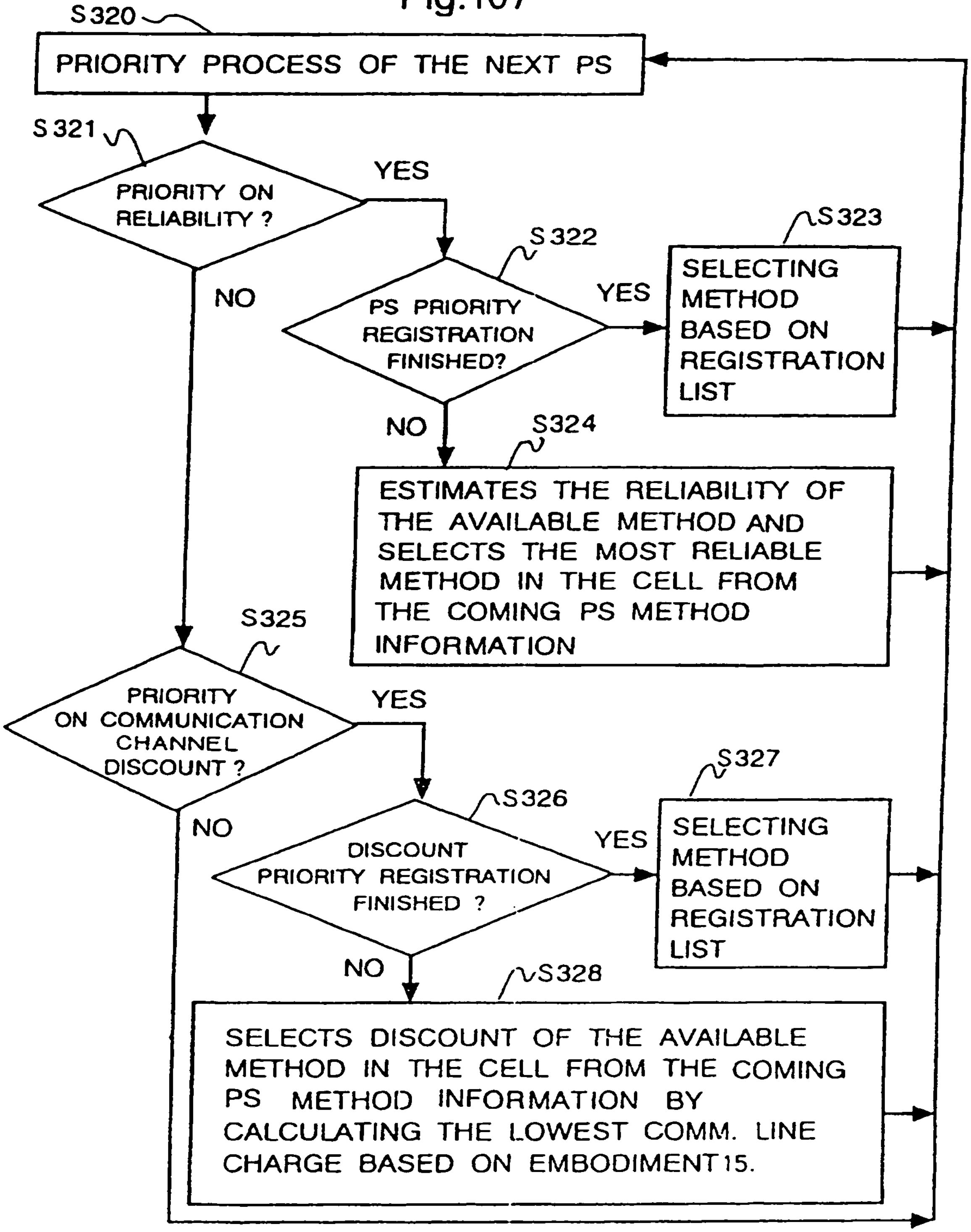
TABLE 5

AN EXAMPLE OF SETTING THE METHOD OF MOBILE STATION

(SELECTION OF THE UNDERLINED METHOD)

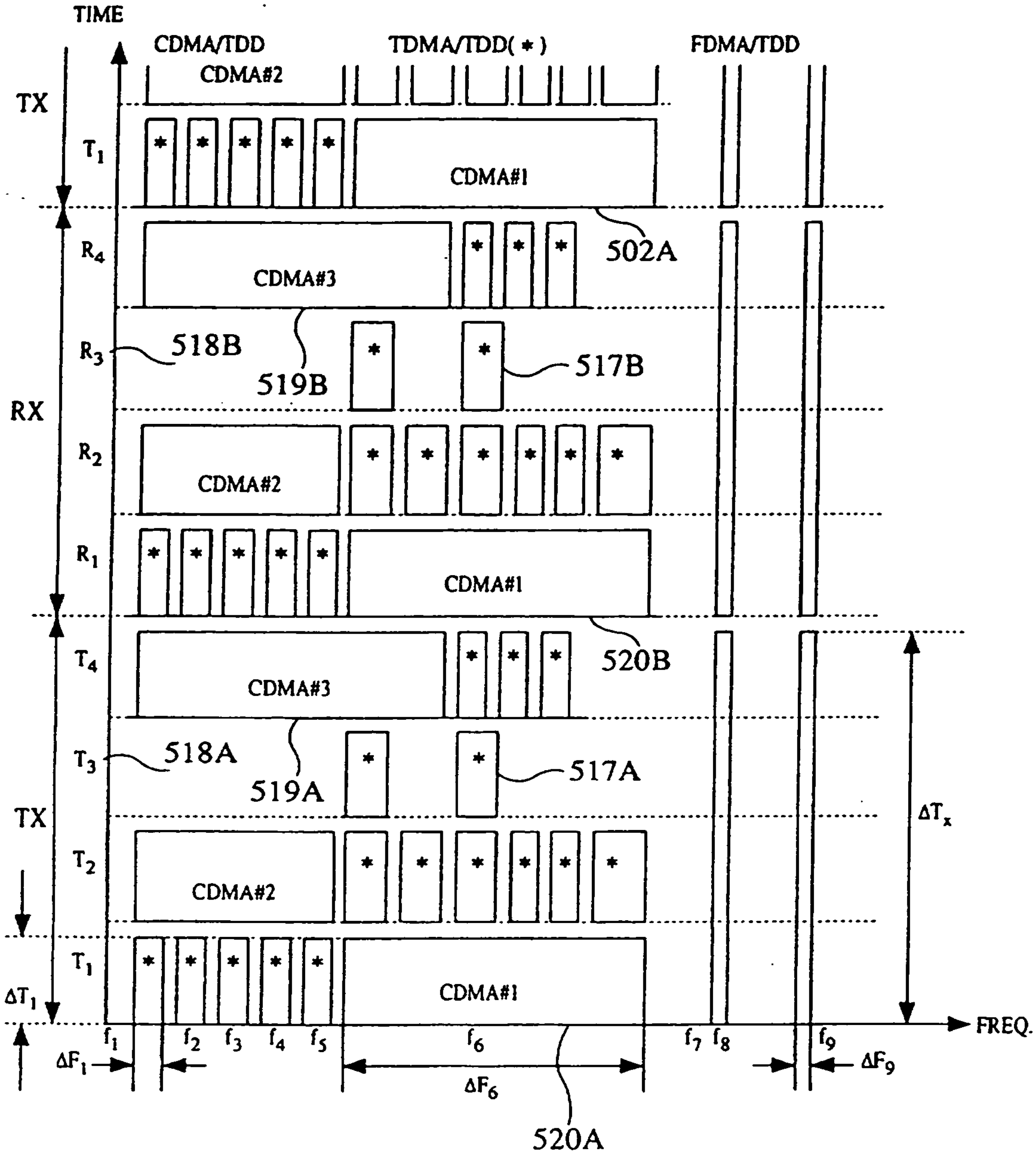
CELL No.	MOBILE STATION NUMBER	LEVEL	ACCESS METHOD	MODULATION METHOD	SS CODE	SPEECH CODING
110	PS046971 (PORTABLE)	1	TDMA/TDD	π/4-QPSK		16K
		2	CDMA/TDD	GMSK	B3654	16K
		3	FDMA/FDD	FM		ANALOG
	2111 (MOBILE)	1	CDMA/TDD	GMSK	B3624	8K
		2	TDMA/TDD	π/4-QPSK		16K
		3	FDMA/TDD	GMSK		12K
		4	FDMA/FDD	FM		ANALOG
	2113 (MOBILE)	1	TDMA/TDD	π/4-QPSK		16K
		2	CDMA/TDD	π/4-QPSK	B3679	16K
		3	FDMA/TDD	π/4-QPSK		32K
		4	FDMA/FDD	FM		ANALOG
111	PS034673 (PORTABLE)	3	CDMA/TDD	GMSK	B3681	8K
		2	FDMA/TDD	GMSK		12K
		1	FDMA/FDD	FM		ANALOG
135	PS092373 (PORTABLE)	1	CDMA/TDD	CMSK	B3692	8K
		3	FDMA/TDD	π/4-QPSK		32K
		4	FDMA/FDD	FM		ANALOG

Fig.107



A FLOW-CHART OF SETTING PRIORITY ASSIGNMENT

Fig. 108

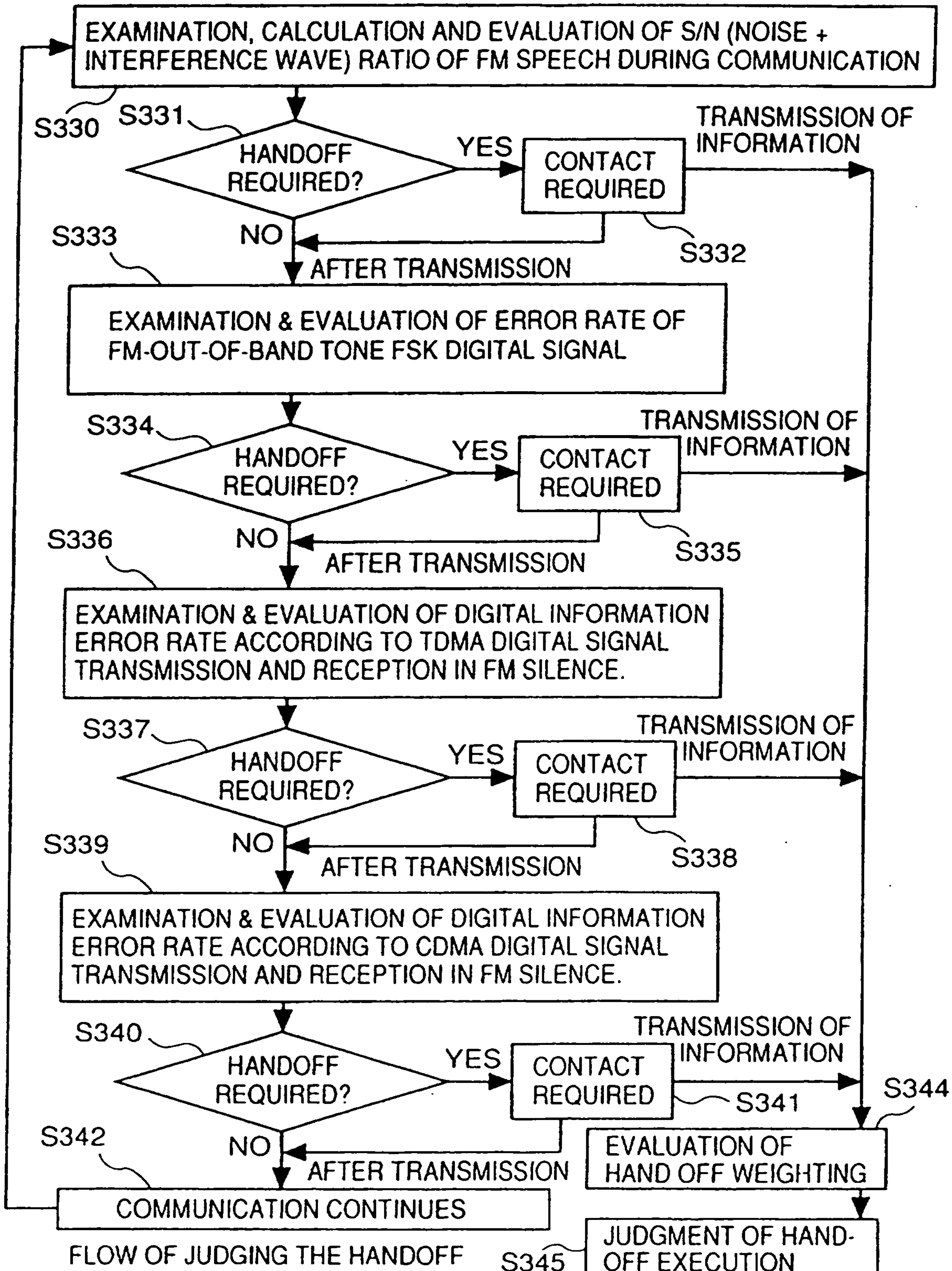


FDMA-f_9 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_9 \times \Delta T_X$
TDMA-f_1 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_1 \times \Delta T_1$
CDMA-f_6 COMMUNICATION CHANNEL EFFICIENCY : $\Delta F_6 \times \Delta T_1/N$

CDMA COMMUNICATION CHANNEL RELIABILITY = S/n

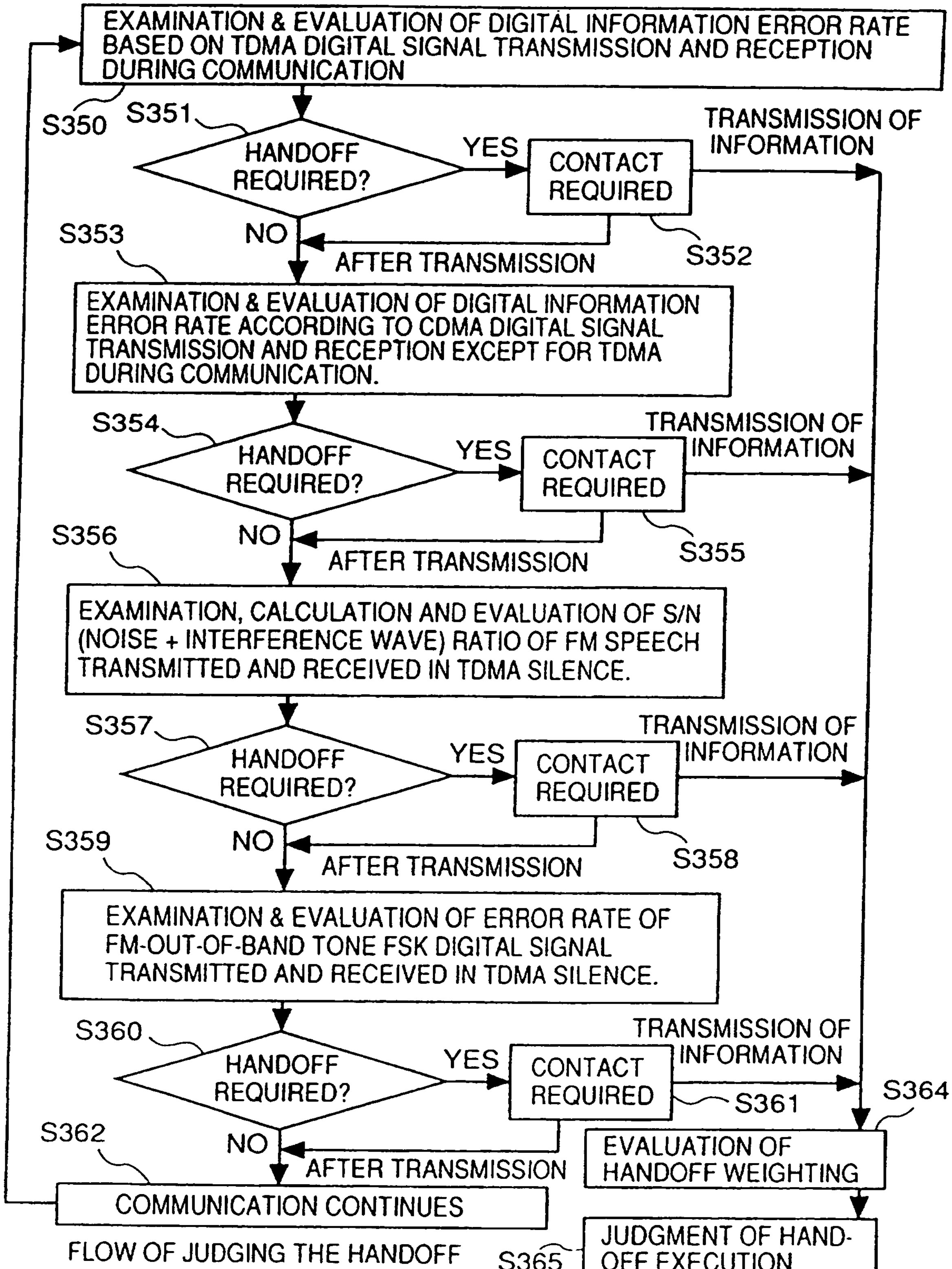
THE CURRENT NUMBER OF COMMUNICATION CHANNELS IN USE : n (THE RELIABILITY IS HIGH WHEN $n \geq 1$)

Fig. 109



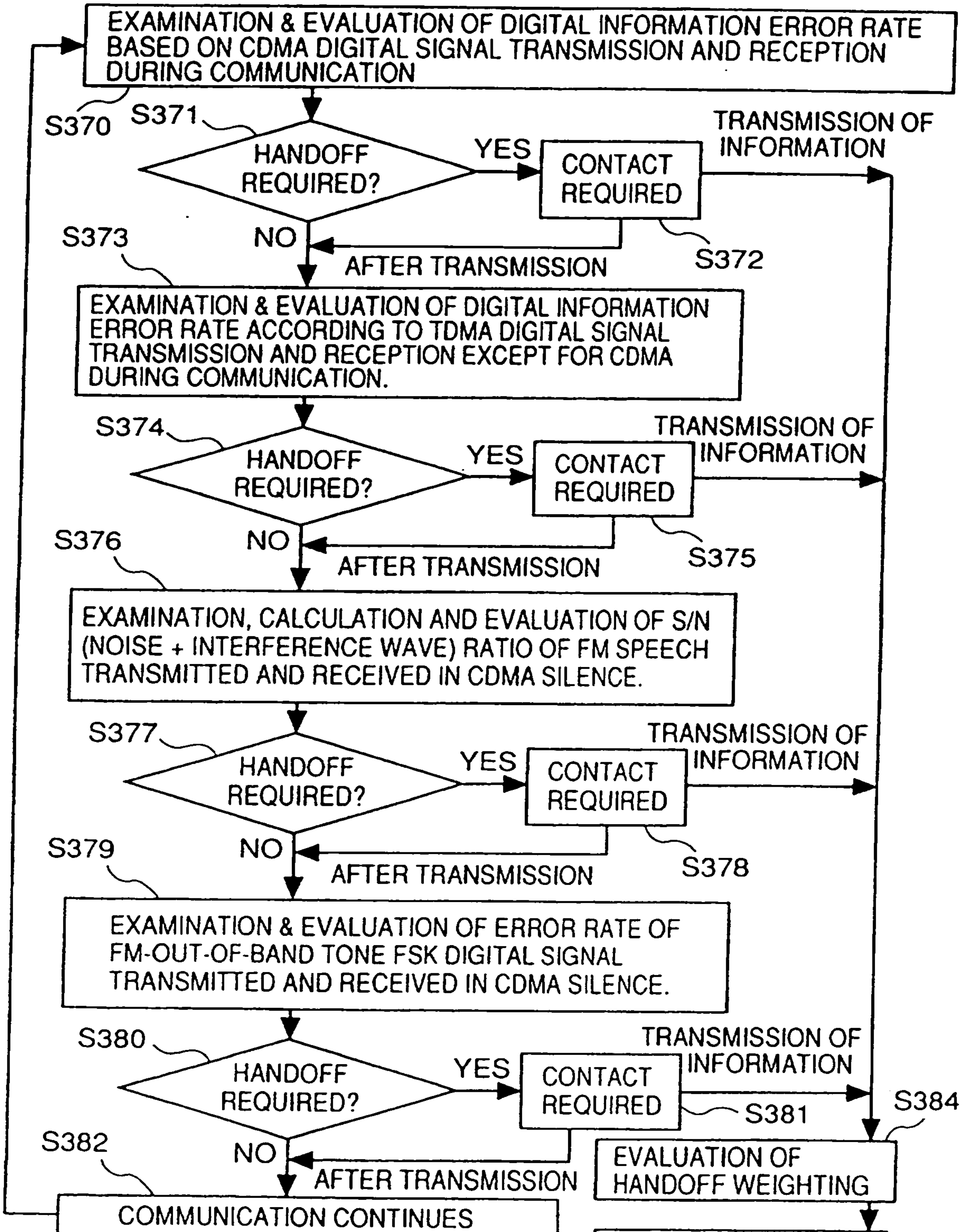
FLOW OF JUDGING THE HANDOFF DURING FDMA COMMUNICATION

Fig. 110



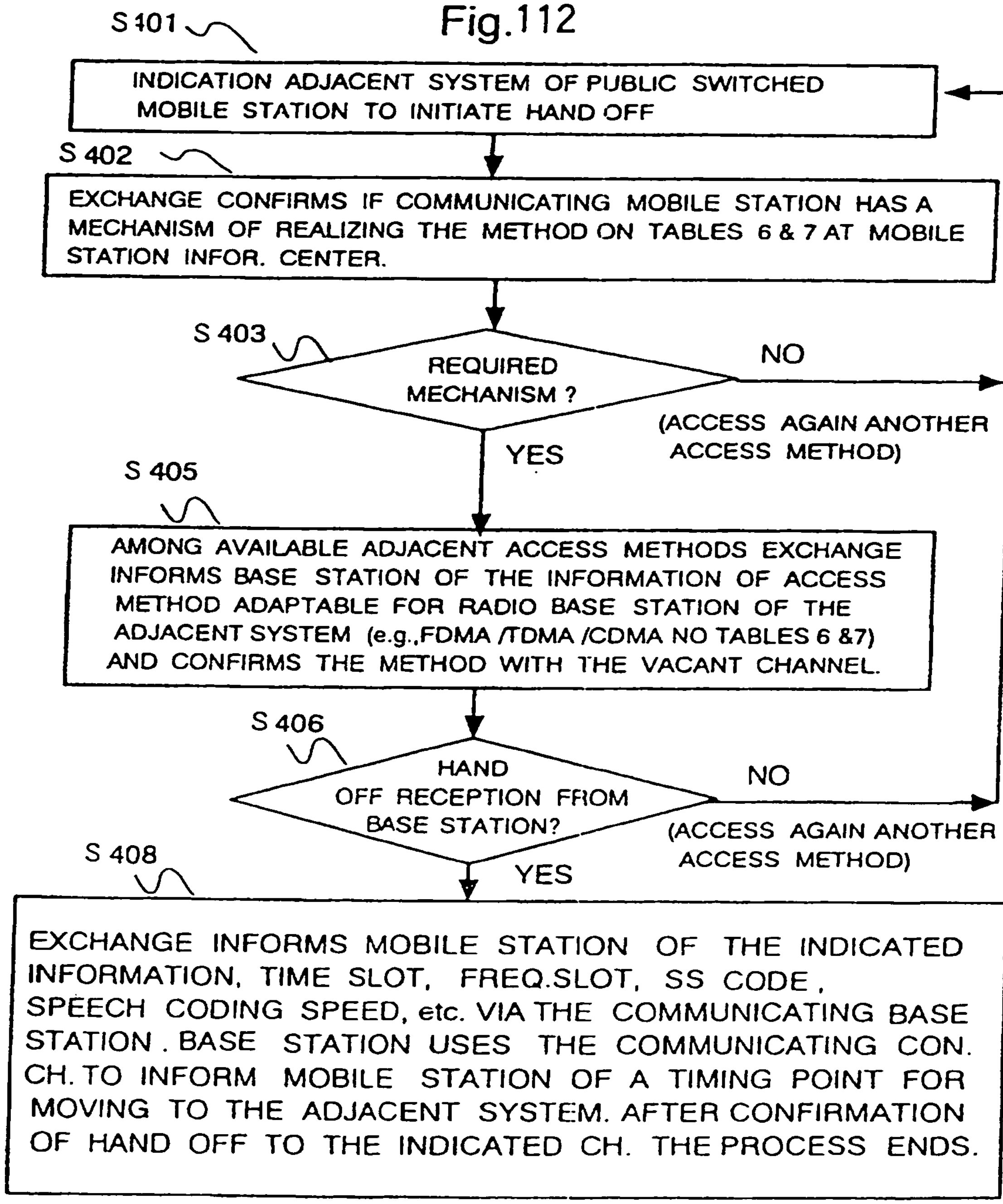
FLOW OF JUDGING THE HANDOFF DURING TDMA COMMUNICATION

Fig. 111



FLOW OF JUDGING THE HANDOFF DURING CDMA COMMUNICATION

Fig.112



HAND OFF PROCEDURE TO THE ADJACENT SYSTEM

Fig. 113

TABLE 6

CONTROL CHANNEL INFORMATION IN THE ADJACENT SYSTEMS

TITLE OF THE SYSTEM	CELL No.	FREQ.	ACCESS METHOD	MODULATION METHOD	SS CODE	REMARKS
TU-KA ASHIYA	110	f_1	TDMA/TDD	π/4-QPSK	B3654-7	Slotted Aloh
		f_5	CDMA/TDD	GMSK		CODE DIVISION
		f_{31}	FDMA/TDD	FSK		Slotted Aloh
		$f_{41/65}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
	111	f_3	CDMA/TDD	GMSK	B3621-8	CODE DIVISION
		f_7	TDMA/TDD	π/4-QPSK		Slotted Aloh
		f_{33}	FDMA/TDD	FSK		Slotted Aloh
		$f_{10/55}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
	112	f_0	TDMA/TDD	π/4-QPSK	B3675-8	Slotted Aloh
		f_{13}	CDMA/TDD	GMSK		CODE DIVISION
		f_{35}	FDMA/TDD	FSK		Slotted Aloh
		$f_{43/65}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
CELLULAR NISHINOMIYA	213	f_{11}	CDMA/TDD	GMSK	B3681-4	CODE DIVISION
		f_{15}	TDMA/TDD	π/4-QPSK		Slotted Aloh
		f_{37}	FDMA/TDD	FSK		Slotted Aloh
		$f_{20/57}$	FDMA/FDD	SPEECH FSK		Slotted Aloh
DOCOMO TAKARAZUKA						
	435	f_2	TDMA/TDD	π/4-QPSK	B3622-5	Slotted Aloh
		f_0	CDMA/TDD	GMSK		CODE DIVISION
		f_{32}	FDMA/TDD	FSK		Slotted Aloh
		$f_{22/60}$	FDMA/FDD	SPEECH FSK		Slotted Aloh

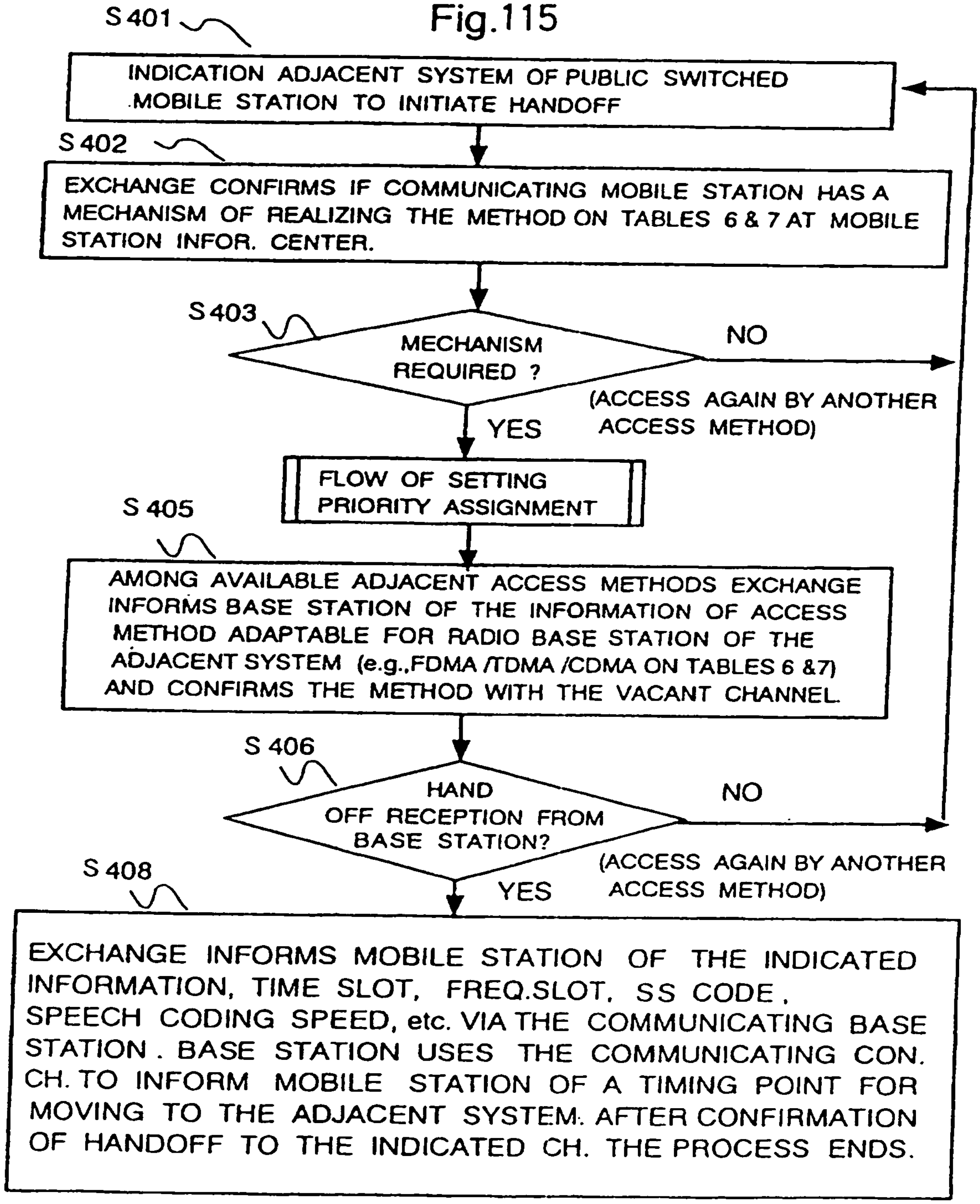
Fig.114

TABLE 7

CONTROL CHANNEL INFORMATION IN THE ADJACENT SYSTEMS

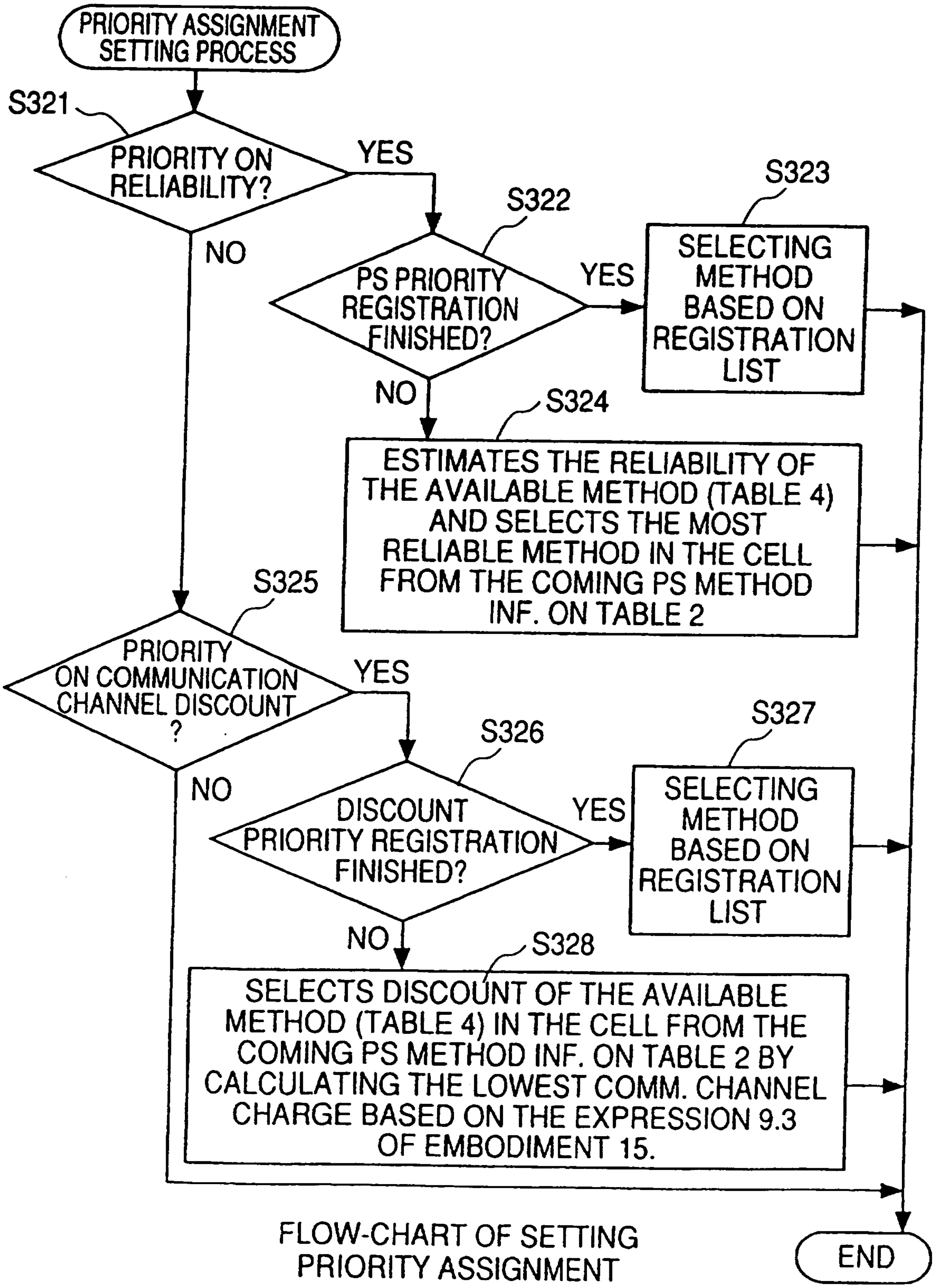
TITLE OF THE SYSTEM	CELL No.	VACANCY ?	FREQ.	ACCESS METHOD	MODULATION METHOD	SS CODE	REMARKS
TU-KA ASHIYA	110	YES YES NO YES	f_4 f_{16} f_{24} $f_{31/76}$	TDMA/TDD CDMA/TDD FDMA/TDD FDMA/FDD	π/4-QPSK GMSK FSK FM	84654-7	CODE DIVISION
	111	YES YES YES YES	f_{14} f_{26} f_{36} $f_{8/57}$	CDMA/TDD TDMA/TDD FDMA/TDD FDMA/FDD	GMSK π/4-QPSK FSK FM	84621-8	CODE DIVISION
	112	YES YES YES YES	f_{24} f_{36} f_{44} $f_{20/50}$	TDMA/TDD CDMA/TDD FDMA/TDD FDMA/FDD	π/4-QPSK GMSK FSK FM	84675-8	CODE DIVISION
CELLULAR NISHINOMIYA	213	YES YES YES YES	f_6 f_{23} f_{26} $f_{45/77}$	CDMA/TDD TDMA/TDD FDMA/TDD FDMA/FDD	GMSK π/4-QPSK FSK FM	84681-4	CODE DIVISION
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
DOCOMO TAKARAZUKA	435	YES YES NO YES	f_{13} f_{20} f_{35} $f_{65/70}$	TDMA/TDD CDMA/TDD FDMA/TDD FDMA/FDD	π/4-QPSK GMSK FSK FM	84622-5	CODE DIVISION

Fig.115



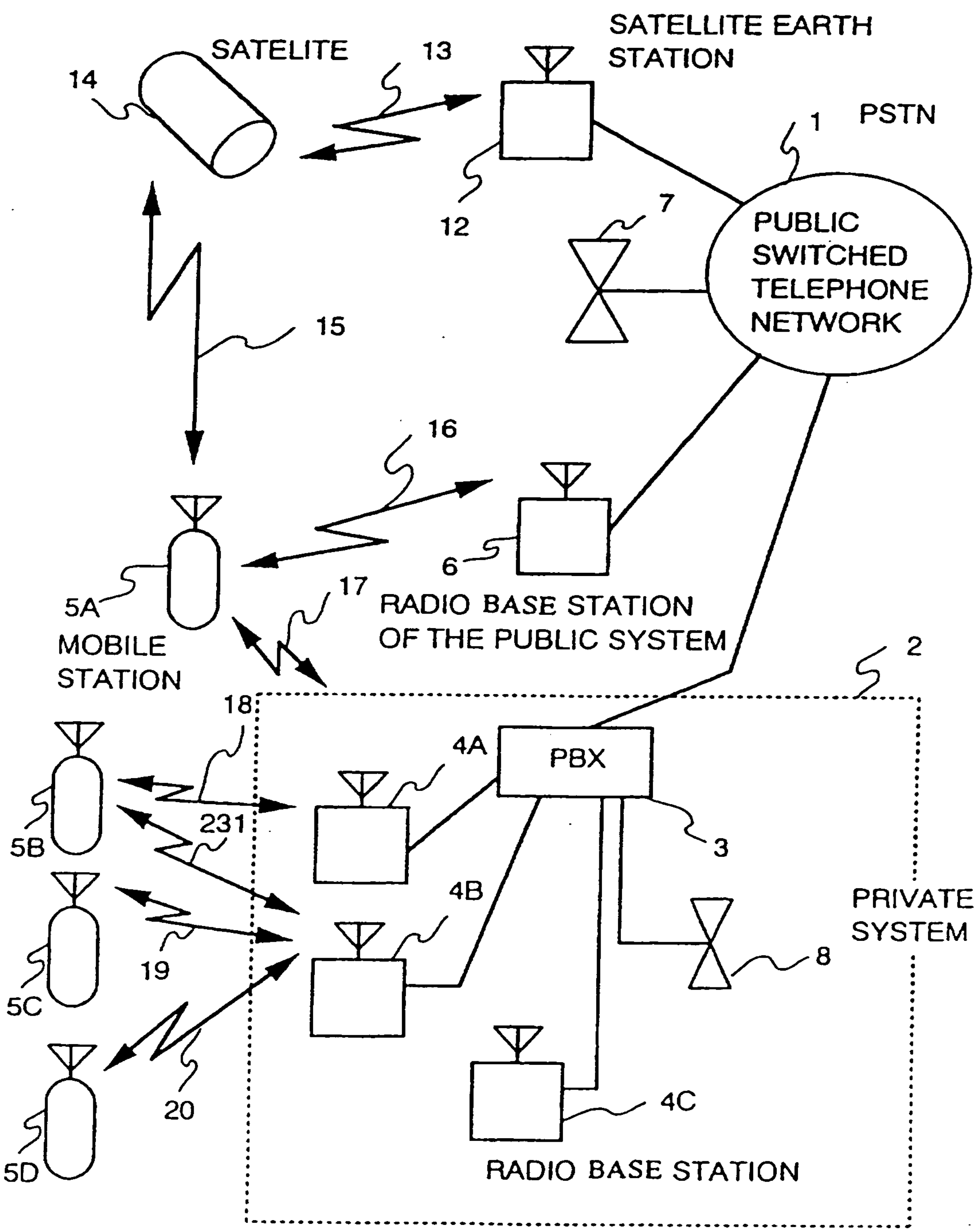
HANDOFF PROCEDURE TO THE ADJACENT SYSTEM OF THE MOBILE STATION HAVING PRIORITY

Fig. 116



FLOW-CHART OF SETTING PRIORITY ASSIGNMENT

Fig. 117



SATELITE
14
13
SATELLITE EARTH STATION
12
1
PSTN
7
PUBLIC SWITCHED TELEPHONE NETWORK
15
16
6
RADIO BASE STATION OF THE PUBLIC SYSTEM
5A
MOBILE STATION
17
2
18
4A
PBX
3
5B
231
4B
PRIVATE SYSTEM
8
5C
19
20
4C
5D
RADIO BASE STATION

Fig. 118

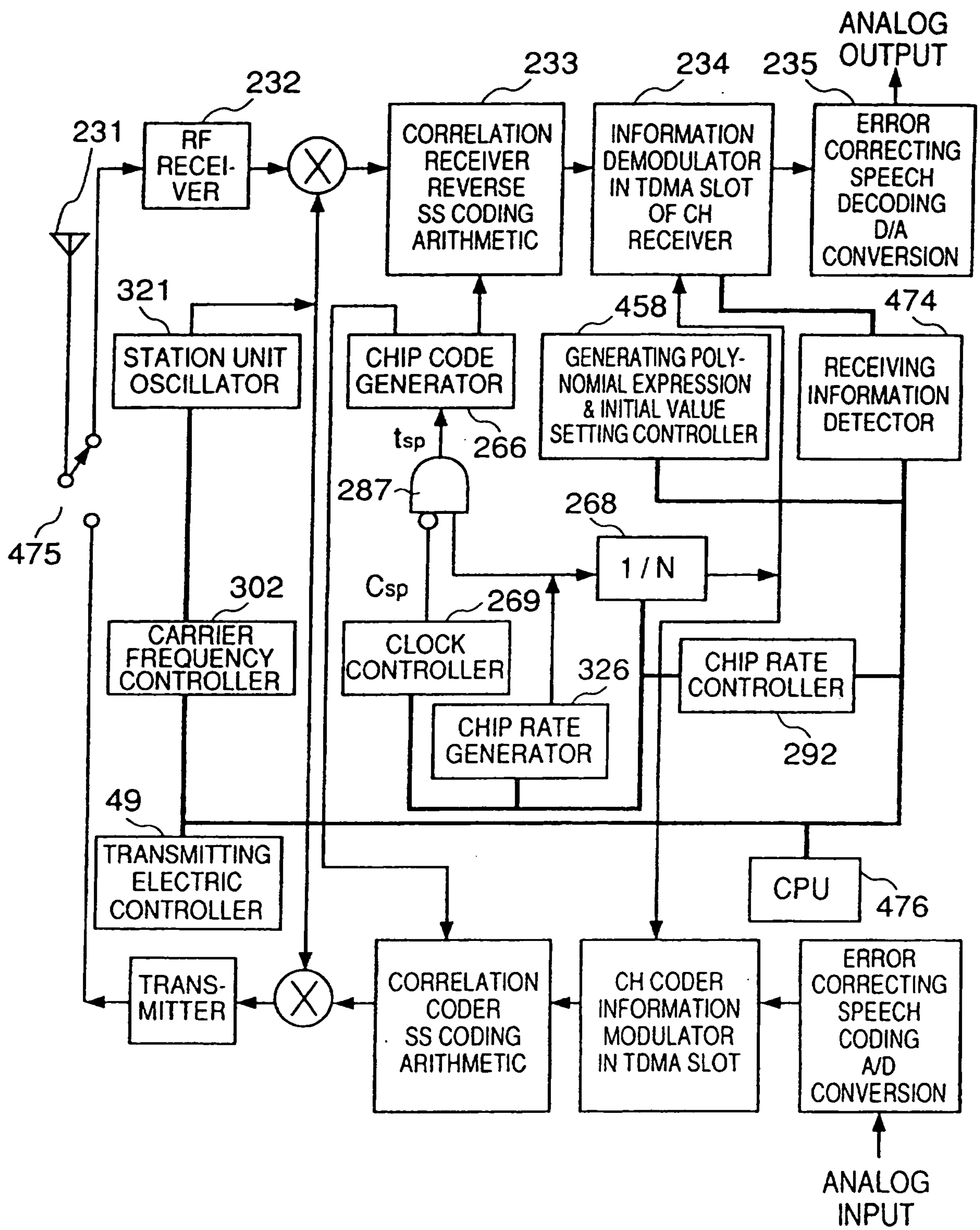

231
232
RF RECEIVER
233
CORRELATION RECEIVER REVERSE SS CODING ARITHMETIC
234
INFORMATION DEMODULATOR IN TDMA SLOT OF CH RECEIVER
235
ERROR CORRECTING SPEECH DECODING D/A CONVERSION
ANALOG OUTPUT
321
STATION UNIT OSCILLATOR
CHIP CODE GENERATOR
266
tsp
287
458
GENERATING POLYNOMIAL EXPRESSION & INITIAL VALUE SETTING CONTROLLER
474
RECEIVING INFORMATION DETECTOR
475
268
1 / N
Csp
269
CLOCK CONTROLLER
302
CARRIER FREQUENCY CONTROLLER
326
CHIP RATE GENERATOR
CHIP RATE CONTROLLER
292
49
TRANSMITTING ELECTRIC CONTROLLER
CPU
476
TRANSMITTER
CORRELATION CODER SS CODING ARITHMETIC
CH CODER INFORMATION MODULATOR IN TDMA SLOT
ERROR CORRECTING SPEECH CODING A/D CONVERSION
ANALOG INPUT

Fig. 119

	SLOT NO.	FREQ. MHz	TRANSMITTING ELECTRIC POWER	TX TYPE	DATA RATE R_D	CHIP RATE $1/t_{SP}$	CHIP CODE POLYNOMIAL	CHIP CODE INITIAL VALUE
CPU SELECTS THE DESIGNATED SLOT	1	f_6	ATT_1	CDMA	R_{D1}	$R_{C1}=N_1R_{D1}$	61	3328
	2	f_3	ATT_2	CDMA	R_{D2}	$R_{C2}=N_2R_{D2}$	12	2635
	3	f_{11}	ATT_3	TDMA	R_{D3}	0	34	9013
	4	f_{12}	ATT_4	CDMA	R_{D4}	$R_{C4}=N_4R_{D4}$	07	7540
		FREQ. CONT.	TRANSMITTING ELECTRIC POWER CONTROLLER	CHIP RATE CONTROLLER			POLYNOMIAL & INITIAL VALUE SETTING CONTROLLER	

Fig.120

	SLOT NO.	DATA RATE R_D (bps)	TRANSMITTING TYPE	CHIP RATE $1/t_{SP}$ (cps)	
ELECTRIC WAVE OF RADIO BASE STATION OF PUBLIC SYSTEM	1	19.2K	TDMA	0	
	2	19.2K	CDMA	12.288M	477
	3	192K	TDMA	0	
	4	9.6K	CDMA	6.144M	
ELECTRIC WAVE OF RADIO BASE STATION OF PRIVATE SYSTEM	1	19.2K	CDMA	12.288M	478
	2	9.6K	CDMA	6.144M	
	3	192K	TDMA	0	
	4	19.2K	CDMA	12.288M	479

Fig.121

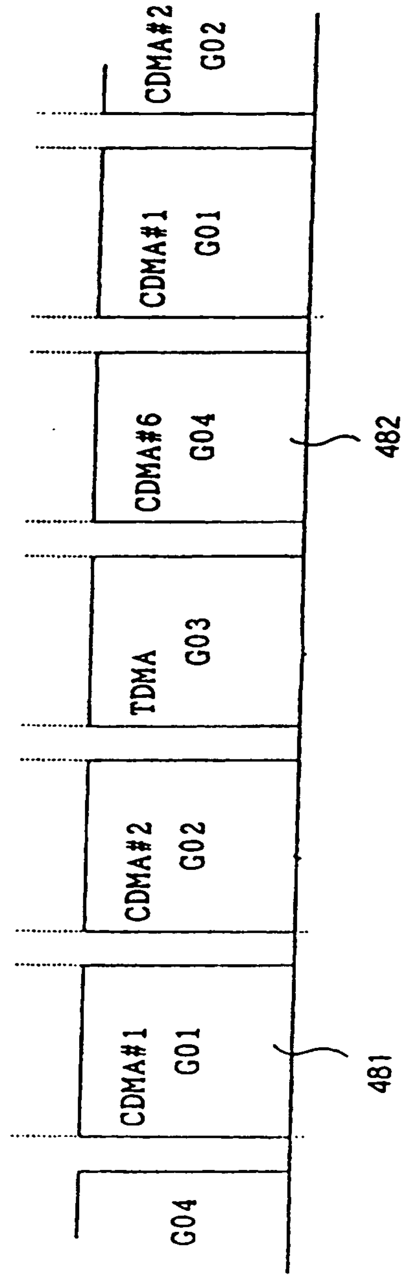
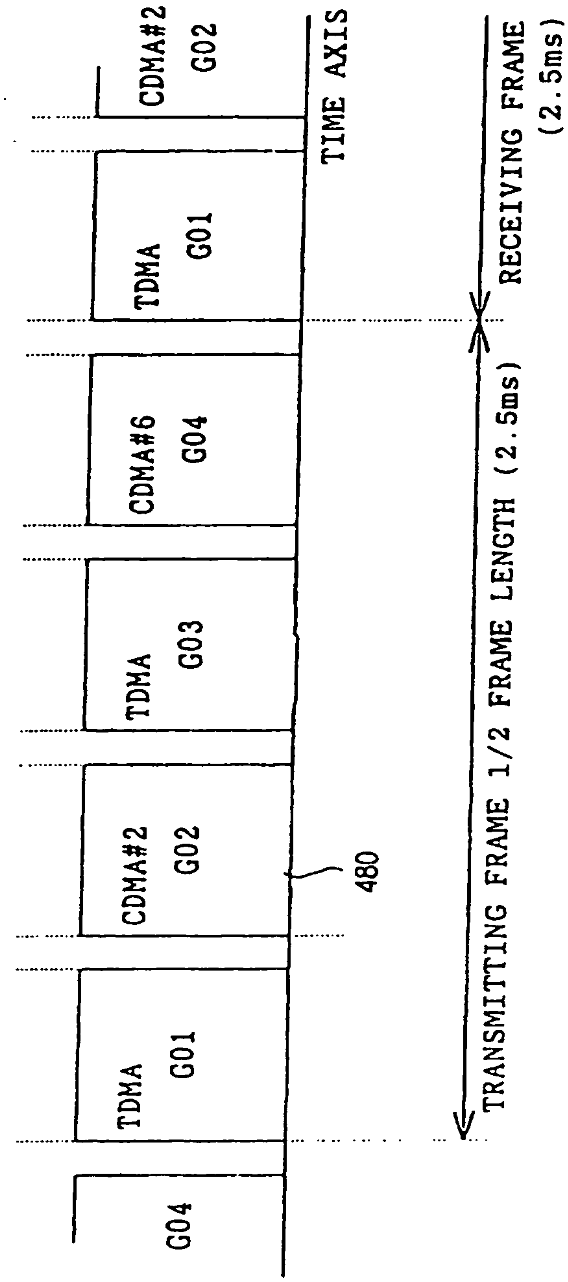

G04
CDMA#1
G01
481
CDMA#2
G02
TDMA
G03
CDMA#6
G04
482
CDMA#1
G01
CDMA#2
G02

Fig.122



TDMA
G01
CDMA#2
G02
TDMA
G03
CDMA#6
G04
TDMA
G01
CDMA#2
G02
G04
TIME AXIS
480
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME
(2.5ms)

Fig.123

	MOBILE STATION NO.	SLOT NO.	DATA RATE R_D (bps)	TX TYPE	CHIP RATE $1/t_{SP}$ (cps)	RECEIVING ELECTRIC FIELD STRENGTH	NUMBER OF SIMULTANEOUS INFORMATION CHS	
REC. ELEC. FIELD STRENGTH FROM MOBILE ST. IN BASE ST. OF PUBLIC SYS.	322	1	19.2K	TDMA	0	-	1	
	101	2	19.2K	CDMA	12.288M	RSS_{101}	36	483
	479	3	192K	TDMA	0	-	1	
	-	4	9.6K	CDMA	6.144M	-	14	
REC. ELEC. FIELD STRENGTH FROM MOBILE ST. IN BASE ST. OF PRIVATE SYS.	-	1	19.2K	CDMA	12.288M	RSS_{101}	7	484
	-	2	9.6K	CDMA	6.144M	-	15	
	328	3	192K	TDMA	0	-	1	
	101	4	19.2K	CDMA	12.288M	RSS_{101}	31	485

Fig. 124

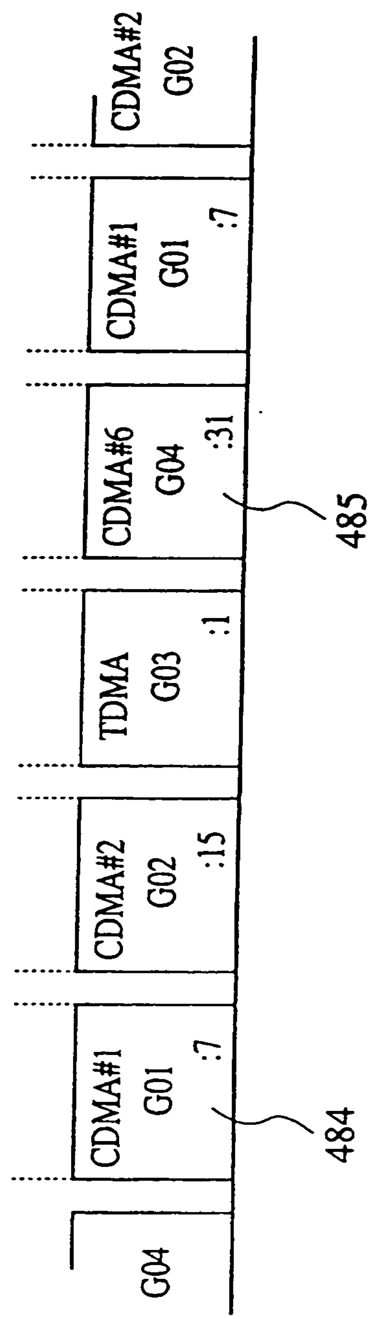

G04
CDMA#1
G01
:7
CDMA#2
G02
:15
TDMA
G03
:1
CDMA#6
G04
:31
CDMA#1
G01
:7
CDMA#2
G02
484
485

Fig. 125

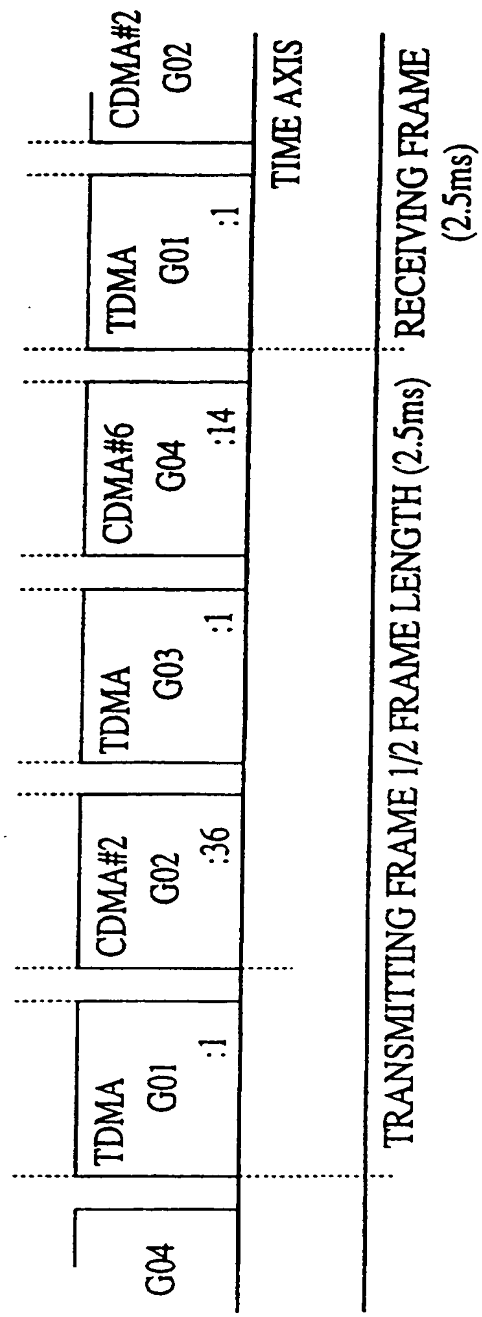

G04
TDMA
G01
:1
CDMA#2
G02
:36
TDMA
G03
:1
CDMA#6
G04
:14
TDMA
G01
:1
CDMA#2
G02
TIME AXIS
TRANSMITTING FRAME 1/2 FRAME LENGTH (2.5ms)
RECEIVING FRAME
(2.5ms)

Fig. 126

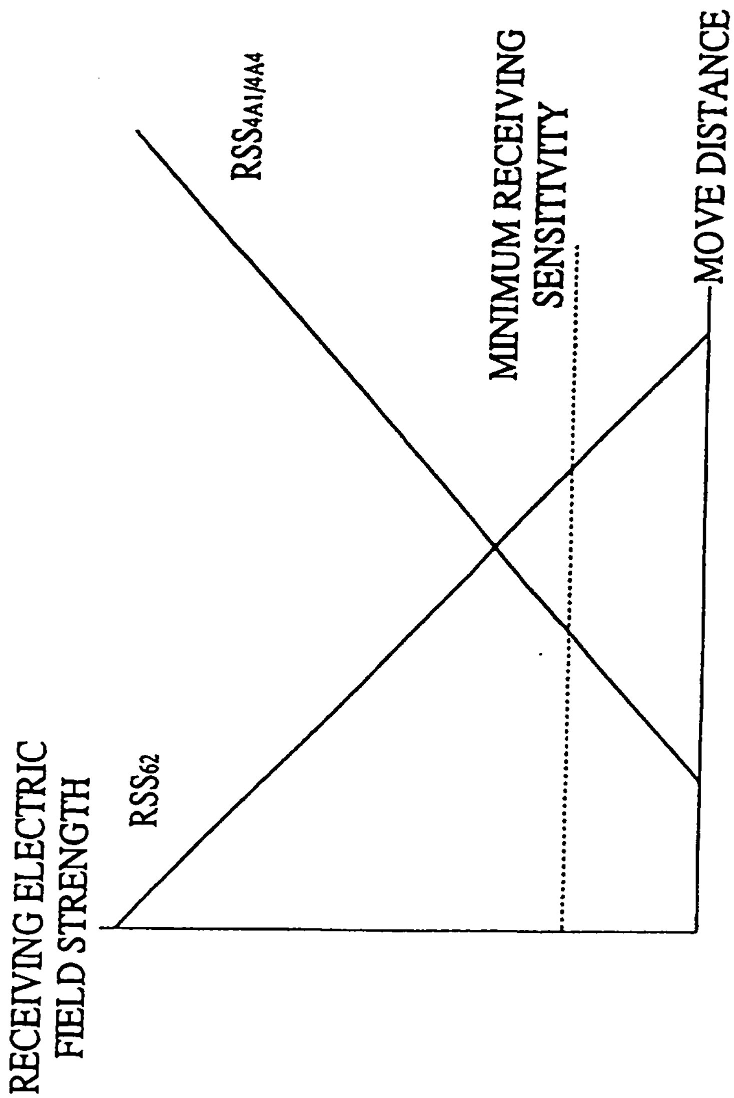

RECEIVING ELECTRIC FIELD STRENGTH
RSS62
RSS4A1/4A4
MINIMUM RECEIVING SENSITIVITY
MOVE DISTANCE

Fig.127

CLASSIFICATION OF MULTIPLE ACCESS METHOD

METHOD		TRANSMITTING SIGNAL	MULTIPLEXING	AN EXAMPLE OF MODULATION METHOD	THE NUMBER OF CARRIER OF SIMULTANEOUS AMPLIFICATION / REPEATER
FDMA	SCPC	ANALOG / DIGITAL	———	LOW SPEED FM / PSK (CONSECUTIVE OR BURST MODE)*	A LARGE NUMBER
	MCPC	ANALOG / DIGITAL	FDM / TDM	LOW SPEED FM / PSK (CONSECUTIVE OR BURST MODE)*	
TDMA		DIGITAL	TDM	HIGH SPEED PSK (BURST MODE)	1
CDMA		DIGITAL	———	PSK (CONSECUTIVE MODE)	A LARGE NUMBER (SOMETIMES THERE OCCURS AN OVERLAP OF SPECTRUM)

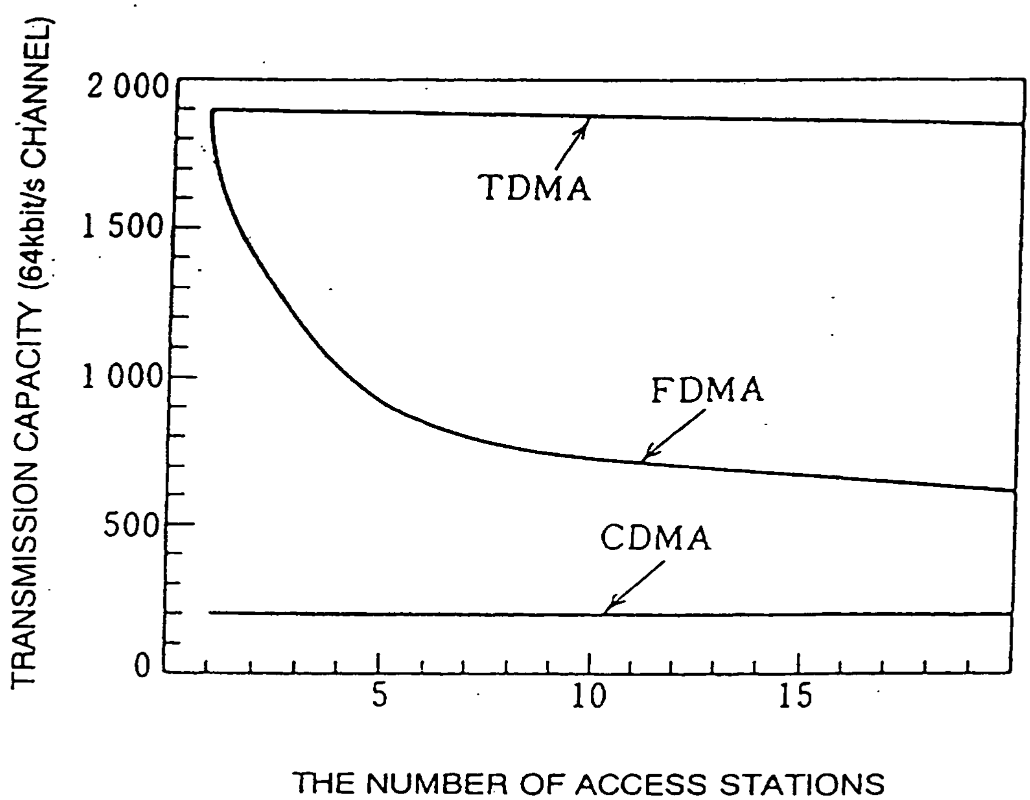
* FREQUENCY DIVISIONAL SIGNAL IS SOMETIMES TRANSMITTED AS BURST MODE FOR EFFECTIVE USE OF THE ELECTRIC POWER OF THE REPEATER

Fig.128

CHARACTERISTICS OF MULTIPLE ACCESS METHODS

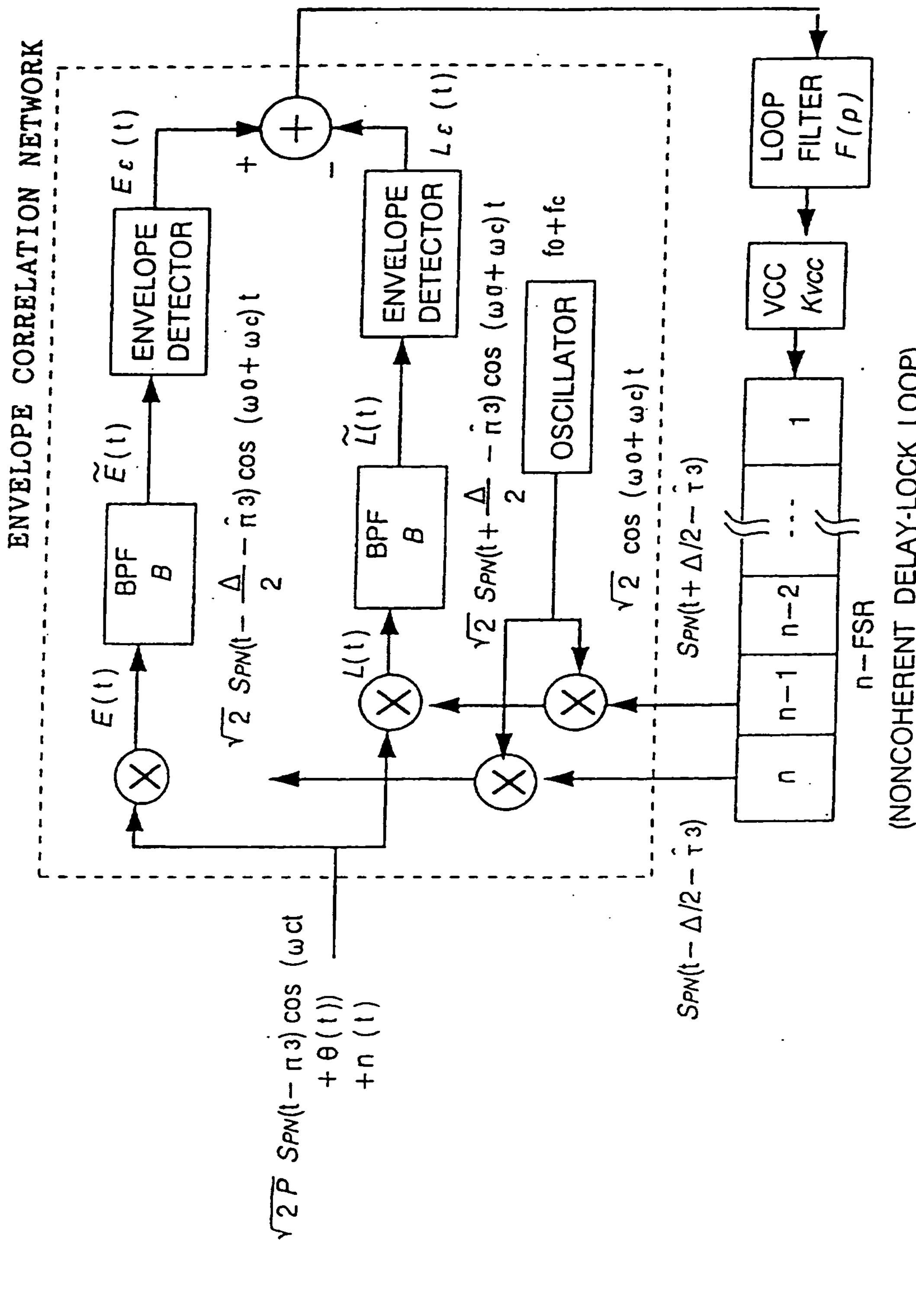
METHOD	ADVANTAGE	DISADVANTAGE
TDMA	(1) EFFECTIVE USE OF ELECTRIC POWER OF REPEATER. (2) TRANSMISSION OF DIGITAL SIGNAL BY VARIOUS SPEEDS. (3) FLEXIBLE CHANGE OF COMMU. CHANNEL CAPACITY FOR FACH STATION (4) EASY CONNECTION BETWEEN BEAMS IN MULTI BEAM COMMU. METHOD	(1) TX CAPACITY OF A REPEATER IS SMALL (AS INCREASING THE NUMBER OF CARRIES, TX EFFICIENCY LOWERS.) (2) LACKING AFFINITY WITH DIGITAL SIGNAL TRANSMISSION OF VARIOUS SOEEDS.
FDMA	(1) THE OPERATION SPEED OF MODULATOR & DEMODULATOR CAN BE SLOW. (2) NO COMPLICATED SYNCH. TO AVOID INTERFERENCE WITH OTHER TX SIGNAL. MULTIPLE ACCESS CAN BE EASILY ACCOMPLISHED. (3) COMM. BY A SMALL EARTH STATION.	(1) NEED SYNC. TO AVOID COLLISION WITH OTHER TX SIGNAL. BASEBAND PROC. IS COMPLICATED (2) NEED ELECTRIC POWER OF EARTH STATION CORRESPONDING TO THE SPEED OF A REPEATER
CDMA	(1) CH. (CODE) IS FIXEDLY ASSIGNED TO EACH STATION. DEMAND ASSIGNED TO EACH STATION. DEMAND ASSIGNMENT IS POSSIBLE. (2) STRONG FOR INTERFERENCE	(1) WIDE BAND REPEATER IS REQUIRED (2) FREQ. USE RATE [bit/s/Hz] IS LOW

Fig. 129



AN EXAMPLE OF TRANSMISSION CAPACITY (/REPEATER) FOR THE NUMBER OF CARRIERS IN EACH MULTIPLE ACCESS METHOD (A REPEATER OF 120 MHZ IS ASSUMED TO BE USED. TRANSMISSION SPEED IS 120Mbit/s IN CASE OF 1 CARRIER. IN FDMA METHOD, 1 CARRIER WAVE / STATION IS ASSUMED)

Fig. 130


ENVELOPE CORRELATION NETWORK
E(t)
BPF B
Ẽ(t)
ENVELOPE DETECTOR
Eε(t)
+
−
Lε(t)
L(t)
BPF B
L̃(t)
ENVELOPE DETECTOR
OSCILLATOR
f0+fc
√2 SPN(t − Δ/2 − τ̂3) cos (ω0 + ωc)t
√2 SPN(t + Δ/2 − τ̂3) cos (ω0 + ωc)t
√2 cos (ω0 + ωc)t
√2P SPN(t − τ̂3) cos (ωct + θ(t)) + n(t)
LOOP FILTER F(p)
VCC Kvcc
n
n−1
n−2
...
1
SPN(t + Δ/2 − τ̂3)
SPN(t − Δ/2 − τ̂3)
n−FSR
(NONCOHERENT DELAY-LOCK LOOP)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 701 337 A3

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:
30.08.2000 Bulletin 2000/35

(43) Date of publication A2:
13.03.1996 Bulletin 1996/11

(21) Application number: 95114123.3

(22) Date of filing: 08.09.1995

(51) Int. Cl.[7]: H04B 7/26

(84) Designated Contracting States:
DE FR GB SE

(30) Priority: 09.09.1994 JP 21618494
01.09.1995 JP 22489895

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(54) **Mobile communication system using various multiple access methods**

(57) A mobile communication system in which various access methods may be selected according to the user's priority. In the mobile communication system, each of a mobile station and radio base stations has a radio processor, which has TDMA, CDMA and FDMA communication units. The CDMA communication unit comprises channel coders each for performing a primary modulation to a transmitting signal, spread-spectrum code generators for respectively generating different spread-spectrum signals, a clock generator/controller for controlling the generation of chip clocks to control the generation of the spread-spectrum codes, oscillators for setting different carrier frequencies to outputs calculated as products, and a CPU for generally controlling various parts or elements to control the assignment of a CDMA signal or a TDMA signal to an arbitrary time slot transmitted from the TDMA communication unit. The radio processor transmits different signals of different access methods existing in each time slot of the same frame different signals.

EP 0 701 337 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 4123

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y A	US 5 285 469 A (VANDERPOOL JEFFREY S) 8 February 1994 (1994-02-08) * column 3, line 8 - line 11 * * column 4, line 3 - line 10 * * column 5, line 22 - line 31 *	1-8, 22-24 17 9-16, 18-21	H04B7/26
X A	US 4 783 780 A (ALEXIS ROGER P J) 8 November 1988 (1988-11-08) * claims 1-3-4-6 *	1-8, 22-24 9-16, 18-21	
X	US 4 799 252 A (EIZENHOEFFER ALFONS ET AL) 17 January 1989 (1989-01-17) * column 4, line 56 - column 5, line 9; claim 1 *	1-8, 22-24	
Y	WO 93 05585 A (ELEKTROBIT OY) 18 March 1993 (1993-03-18) * page 4, line 19 - line 25 *	17	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 July 2000	Sorrentino, A

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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The members are as contained in the European Patent Office EDP file on
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11-07-2000

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